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TRANSACTIONS

OF THE

AMERICAN ENTOMOLOGICAL SOCIETY

VOLUME LXXXV

THE LAMPYRID FIREFLIES OF JAMAICA

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I. Introduction

The fireflies of the family Lampyridae have always been a subject of both scientific and popular interest. The ability to produce light, possessed by many of the species, makes them conspicuous, and the fact that this luminosity is somehow dependent on chemical mechanisms similar to those of other physiologic processes (Harvey, 1952) renders them of great scientific interest and attention. The relation of the luminosity to mating is a very interesting example of the adaptation of a function. The different species of insects of this family show, in general, a rather remarkable similarity in both appearance and structure indicating close evolutionary relationship, while the differences in the fine structure of the luminous organs (Buck, 1948) may have a phylogenetic significance. The loss of the luminous power —or its failure to develop—in the adults of some species, even though their larvae may be luminous, poses further interesting

questions. Fireflies may be found almost everywhere in the world, in all continents, and although the greatest number of species are found in tropical and semi-tropical regions, particularly in Central and South America, a few are known from such cold places as Newfoundland and Tierra del Fuego.

There are countless references to the lampyrid fireflies in both scientific and popular literature, but it is interesting to note that those of Jamaica have been the subject of frequent comment in the older literature (Sloane, 1707; Browne, 1756; Darwin, 1836; Gosse, 1851, and others). At present there are recognized on the small island of Jamaica, only 4,500 square miles in area, approximately fifty distinct species of Lampyridae with at least two subspecies and several varieties, and apparently only one of these species is a recent immigrant. In contrast, attention may be called to Australia, with an area of 3,000,000 square miles, from which only about two dozen species of lampyrids have been reported, and the members of at least one genus of these, *Luciola,* are probably fairly recent immigrants from New Guinea, only 100 miles away. Australia has been isolated since the late Cretaceous, possibly before the lampyrids had spread sufficiently to be represented in the endemic fauna.

In the following pages an attempt has been made to bring up to date and systematize the accumulated information on the lampyrid fireflies of Jamaica with descriptions of the species designed to facilitate identification, their distribution on the Island, their habits, etc., and such conclusions as appear to be justified.

We wish to acknowledge, with appreciation and sincere thanks, the assistance to this work which has been given (1) to John B. Buck by the National Research Council in financing his trip in 1936; (2) by the American Philosophical Society, Grant No. 520, in 1941; (3) to F. A. McDermott, by the American Philosophical Society, Grant No. 1370, Penrose Fund, for traveling expenses in 1951. Buck also acknowledges with pleasure the many specimens collected for him by his companions in 1941, Drs. W. Gardner Lynn, J. N. Dent, and J. P. Marbarger, and the extensive help in collecting given by his wife, Elisabeth Mast Buck. To Director C. Bernard Lewis of the Institute of Jamaica, and his associates, we are indebted for many courtesies and much valu-

able assistance. The figures were kindly drawn for us by Dr. Margaret Keister and Idolene Hegemann Darrow.

II. Historical

The first species of Jamaican fireflies to be mentioned in the literature were *Photinus pallens* and *Photuris jamaicensis*. The former was referred to by Browne (1756) as "*Pyralis minor*," and given its present specific name by Fabricius (1798). *Photuris jamaicensis* was seen by DeGeer (1794) but regarded by him as the North American *P. versicolor*, and not until 1886 was it recognized as a different species by E. Olivier who gave it its present specific name. Gosse (1848; 1851) described and named *Photinus* (*Pygolampis*) *xanthophotis*, the largest lampyrid so far found on the Island. He remarks that fourteen species of fireflies are present, some giving a green light and others yellow, but he too regarded the *Photuris* as the same as the North American species with which he had presumably become familiar during his residence in Alabama. Darwin (1836) commented on the large number of fireflies in Jamaica. In 1888 E. Olivier described *Photinus melanodactylus* from Jamaica but suppressed it as a synonym of *P. pallens* in 1907; in 1907 he described *P. opulentus* but in 1912 suppressed this as a synonym of *P. xanthophotis*. In 1899 Olivier described *P. maritimus* from Jamaica.

Thus, at the end of the 19th century, only four lampyrids had been definitely described from Jamaica, three *Photinus* and one *Photuris*. Mr. E. Stuart Panton, then curator of the Institute of Jamaica, sent to E. Olivier a series of fireflies collected in the mountains in the parishes of Clarendon and Manchester, and from these Olivier (1907) described *Photinus commissus, P. contemptus, P. ebriosus, P. suavis,* and *P.* (now *Diphotus*) *pantoni*, thus increasing to nine the described Jamaican species. Leng and Mutchler (1922) published a revision of the Lycidae, Lampyridae, and Cantharidae of the West Indies; they added *Photinus ceratus* as a new Jamaican species but concluded that Olivier's *P. maritimus* and *P. contemptus* were synonyms since intermediate forms were found between the dark *maritimus* and the paler *contemptus*. The next year Mutchler (1923) added

one new species, *P.* (now *Diphotus*) *unicus.* Gowdey (1926) lists nine species, of which two are synonyms, including the questionable *P. maritimus* and *P. contemptus.*

In 1936 Buck collected about five hundred specimens of Lampyridae in Jamaica and these were used for a revision of the Jamaican species by Barber (1941). Barber had before him not only Buck's collection but the specimens of Leng and Mutchler from the American Museum of Natural History, those collected by Lund in 1910, Miller in 1931, Chapin and Blackwelder in 1936–1937, and other miscellaneous material, as well as the specimens sent to Olivier by the U. S. National Museum in 1911 and returned with a considerable number bearing Olivier's identifications. In examining all of this material it became evident that the older, brief descriptions were inadequate, and that in many cases two or more obviously distinct species had been included under the same specific name and, conversely, specimens of a single species had been distributed between two or more species. Thus, Barber found under the name *Photinus maritimus,* specimens which were really those of two other species, *P. lucernula* and *P. evanescens.* It has been impossible to identify among the specimens an individual entity which can be definitely ascribed to Olivier's *P. suavis;* three different species were included under this name by Leng and Mutchler—*P. morbosus, P. leucopyge,* and *P. lundi.* It thus becomes impossible to identify as specific entities Olivier's *P. maritimus, contemptus,* and *suavis.* Olivier's description of his *P. ebriosus* (1907) is inadequate to distinguish between the two species which Barber named *P. euphotus* and *P. amplus.* (Specimens of *P. euphotus* sent to Dr. Guy Colas of the Muséum National d'Histoire Naturelle, Paris, were reported by him to agree with Olivier's type of *P. ebriosus,* but specimens of *P. amplus* were not available to send to Dr. Colas at the time, so a comparison of the latter with the type of *ebriosus* has not been made.) Olivier's *Photinus pantoni* (1907) belongs in Barber's genus *Diphotus,* and while close to *D. montanus* Barber, a paratype kindly loaned by Dr. A. Descarpentries, of the Paris Museum, from Olivier's collection, proved quite definitely identical with Barber's *D. mutchleri.* Therefore, *mutchleri* must be suppressed in favor of

Olivier's *pantoni*. Barber's *Photinus euphotus* and *P. amplus*, which are quite distinct, have been retained and Olivier's *P. ebriosus* given as a synonym in part for both.

As a result of this work by Barber (1941), the total number of lampyrids described from Jamaica was raised to thirty-six, plus eight subspecies; four species of *Photinus*, two of *Diphotus* (originally described as *Photinus*), and one each of *Photuris* and *Pyractomena* being accepted from the earlier descriptions. Barber erected three new genera, *Diphotus*, *Jamphotus*, and *Microdiphot*.

In 1941 Buck again visited Jamaica and returned with a much more extensive collection of about nineteen hundred specimens. Mr. Barber was studying these at the time of his most regrettable death on June 1, 1950. He had distributed the bulk of them in their proper specific categories and was attempting to solve some of the puzzling situations arising from the great similarity of several of the species. Buck (1947) described ten new species which had been found in collections, thus raising the total number of species to forty-six, and introducing one new genus, *Presbyolampis*. In 1951–1952, McDermott visited Jamaica and was able to collect specimens of about a dozen species in the rather unfavorable winter months in scattered localities over most of the Island and also went over the fairly extensive material which had accumulated at the Museum of the Institute of Jamaica. No new species developed from this study, but two new species of *Diphotus* have since been collected by Dr. Thomas H. Farr, Research Entomologist of the Institute of Jamaica.

The forty-eight recognizable species of Jamaican lampyrid fireflies, herein treated, distribute by genera as follows: *Photinus*[1] —29, *Diphotus*[2]—13, *Microdiphot*—2, *Lecontea*[3]—1, *Jamphotus* —1, *Photuris*—1, *Presbyolampis*—1. These generic names are used in their currently accepted sense. Barber has cast doubts

[1] Plus 7 subspecies as given by Barber. One of Barber's subspecies, *Photinus lobatus morbosus*, has been somewhat doubtfully given specific rank as *P. morbosus*.

[2] Another species, *Diphotus glaucus* (G. A. Olivier, 1790), has been listed as from Jamaica by E. Olivier (1911b) but its occurrence there is doubted.

[3] In his posthumous monograph on "North American Fireflies of the Genus Photuris," Barber (1951) gives the reasons for replacing *Pyractomena* with Olivier's *Lecontea*.

on the validity of *Photinus* and his *Diphotus* may also be questionable. At this time we do not wish to enter into this phase of the nomenclature. We have, however, used E. Olivier's *Lecontea* for *Pyractomena* LeConte, although *Lecontea* is not strictly allowable by the rules of the International Commission. Its use seems preferable to having two such very similar genonyms as *Pyractomena* and *Pyractonema* in the same family of insects. Moreover, Barber (1951) has pointed out that *Pyractonema* Solier is a misspelling. If it were emended it would be the same as *Pyractomena,* but being established prior to LeConte's *Pyractomena* there would seem to be no point in cluttering up the literature with an emendation at this time if this last genonym is replaced by *Lecontea* (see Green, 1957).

III. Taxonomy

Perhaps at the start we should define our concept of what constitutes a "species" and for this purpose we will quote Dobzhansky (1937) ". . . the stage in the process of evolutionary diversification at which the previously freely interbreeding array of forms splits into two or more separate arrays prevented from interbreeding with each other by some physiological isolating mechanism."

All species of lampyrids have, of course, many features in common and these do not need to be repeated here. In these family characters the Jamaican species do not present any special variants, nor do these species differ greatly from those in the same genera from other localities. Two genera, *Microdiphot* and *Presbyolampis,* are confined to Jamaica so far as we know. *Diphotus* is distributed through the Antilles and may possibly be represented in South America. *Photinus, Photuris,* and *Lecontea* are represented abundantly in North, Central, and South America. The obvious generic differences are in the location of the light organs (*Photinus* and *Diphotus*), the form of the body (*Microdiphot*), the structure of the claws (*Photuris* and *Presbyolampis*), and the aedeagal pattern in all genera. These characters have been used in the formulation of the key.

All of the species so far found are luminous (one specimen of *Diphotus montanus* appears to have lost the luminous tissue

from its light organs); all have the characteristic enlarged pronotum covering the head, the eyes being normally only partly visible from above in *Photuris* and *Presbyolampis;* all have simple, unbranched antennae of eleven articles, the basal one usually being longest and the second shortest, except in *Photuris* and *Presbyolampis;* all tarsi are 5-segmented, the fourth being small and bearing relatively large pulvilli; all have eyes at least relatively large, those of the females being less so; abdominal spiracles are dorsal.

Some of the characters frequently used in specific descriptions of insects are either absent or of no specific value in the Jamaican Lampyridae. Thus there are no scales, the characteristic arrangement of which is sometimes of taxonomic use, and aside from the tibial spurs, which are absent or practically so in *Diphotus* and apparently always in the same arrangement in *Photinus,* there are very few spines, long setae, etc. Vestiture is generally more pronounced in some species but is variable intraspecifically, although there are some cases of localized hairiness. Punctulation or granulation of the elytra and pronotum—except the disk of the latter—is a rather general feature of all of the species. The epipleurae are similar in the elytra of all of the species of *Photinus, Diphotus,* and *Photuris.* Distinctive elytral patterns or markings are found in only four species of *Photinus.* Elytral markings of *Lecontea gamma* and *Photuris jamaicensis* are also distinctive, though frequently obsolescent, but only one species in each of these latter two genera is known to be present in Jamaica. Eleven species of *Photinus* may be said to be easily recognizable.

A minute examination has been made of specimens of each species for characters which may be of value in identification and these are included in the descriptions of the species. All too often recourse must be made to removal of the aedeagus to enable a definite identification.

General Characters of the Jamaican Lampyridae

The Pronotum.—This structure is enlarged so that it usually covers the head of the insect and extends laterally nearly or quite to the lateral edges of the elytra at the humeri. The outline of the pronotum is generally semi-elliptical, but may be approximately ogival or semicircular; usually wider than long, especially in females; the posterior margin is usually at least slightly sinuate, and the lateral and anterior margins may be also. The baso-lateral angles may be fairly acute or rounded, and generally project posteriorly beyond the median line of the basal edge. Frequently there is a longitudinal median sulcus, which may vary from a narrow groove or crease to a relatively wide, shallow depression. There is some question as to whether this sulcus is of diagnostic value as it seems to differ in different specimens of the same species, and it is possible that some change in form may result from contraction in drying. In place of a sulcus a low carina may sometimes be present. The head and eyes frequently show through the pronotum to some extent, as, though mostly opaque, it may be partially translucent or even nearly transparent in the apical portion. There is frequently a pigmented spot which may be black, brown, yellow, or merely a faint discoloration on the disk, and the shape of this pigmented area, or at least the distribution of the pigmentation, is fairly constant for a given species, although sometimes very similar in several species. The disk is generally convex and smooth, but with the lateral areas explanate and rather densely and coarsely punctate. Pink, red, or orange-colored areas may be present; these sometimes tend to fade out in old dry specimens.

The Scutellum.—This is usually small and kite- or coffin-shaped, with rounded apices and lateral angles; it may be concolorous with the elytra, or markedly lighter.

The Mesonotal Plates.—These two sclerites, lying under the base of the pronotum and adjacent to the scutellum, are frequently of a different color from the latter, which constitutes a character of diagnostic value. Their outline is subject to some variation, but is usually that of a half-crescent.

The Elytra.—These usually appear rather densely granular under oblique illumination, and are usually more or less hairy; their lateral margins may be parallel, sub-parallel, or outwardly curved so as to give an elliptical outline. Their ground color varies in different species from the very pale yellowish grey of *Photinus pallens* to the black of *P. synchronans;* the color may appear decidedly lighter under strong illumination, as in examination with a dissecting microscope, or by transmitted light in the absence of the underlying wings. In some species the elytra have lateral borders of a lighter color, usually distinctly white or yellow. These borders may be complete, or reach only a part of the elytral length. A very narrow sutural border is also usually present. In most species there are definite, though sometimes very narrow, explanate lateral margins on the elytra, and these margins may be widened in some portion, a character of diagnostic use. Each elytron bears from one to three costae, which appear to be lines of exaggeration of the general granulate surface structure and are probably thickenings of the chitin to give greater rigidity. These costae begin near the base of the elytron and end indefinitely at ¼ to ¾ of the elytral length. They may occasionally be lighter or darker than the ground color, but should not be mistaken for vittae. Their number and length are not necessarily constant for a given species and cannot be depended upon for diagnostic purposes.

The Legs.—The general structure of the legs is very similar in all species and requires no special comment. The presence or absence of tibial spurs, and their number on the pairs of legs, should, however, be noted. In *Diphotus* and *Microdiphot* the tibial spurs are either very small or indistinguishable from hairs, and may be at least apparently absent. The claws are simple in *Photinus* and *Diphotus;* in *Photuris* the outer claw is bifid, and in *Presbyolampis* both are.

The Head.—The eyes are usually relatively large and hemispherical as seen in lateral aspect. In frontal view they are separated by the frons, the edges of which are more or less divergent upwards and may be straight or slightly curved. The epistome and clypeus differ somewhat between genera but specific differences are unusual. The terminal article of the maxillary palpus

is usually long-conoidal in shape, but somewhat flattened on the inner surface, and may have a depression just below the apex giving the effect of a "finger tip." The corresponding portion of the labial palpus in *Photinus* is securiform; in *Diphotus* it is generally proportionately smaller than in *Photinus* and usually appears as a pointed organ with a small spur at the base rather than triangular; in *Photuris* it is long-mitten shaped with the "thumb" projecting at a right angle. Neither the mandibles nor the antennae present any notable feature, although the length of the latter in reference to the body length should be noted. The mandibular measurements given in the descriptions are the distance across the outside of the semicircle formed by the mandibles in the closed position.

The Abdomen.—The degree of pigmentation of the abdominal tergites and sternites is of considerable diagnostic importance. Unfortunately these characters were not usually noted in the older descriptions, which makes comparison with recent data difficult. The segments bearing the luminous organs may be appreciably wider and/or longer than the other segments. Green (1956, p. 562) has noted that the term "sternite" strictly applies only to the median portion of the ventral surface of the abdominal segments. However, the term is frequently used in this paper for the entire ventral surface of the segment.

The Luminous Organs.—The extent and distribution of the luminous tissue is a very definite generic character, and in a few instances of specific value. These variations are covered in the following key.

The Aedeagi.—Since the aedeagus is sometimes the ultimate, and in some cases the only criterion of a species, plates (pls. 4–13) showing this organ for all of the species for which it is available are included along with a table (table 2) showing the affinities of the various species on the basis of aedeagal structure.

Variation.—No character, not even the aedeagus, is absolutely constant intraspecifically, and some features frequently recorded in the description of a species may vary so much through a series of specimens that they can hardly be regarded as of definite diagnostic value. Some of these follow.

The shape or outline of the pronotum is by no means constant

in a given species, and the sinuosity of the margins and the acuteness and length of the angles are also variable. The ratio of width to length may vary considerably. Thus in *Photinus pallens* ratios of 1.11 to 1.67 were found in seventy-four males, and 1.34 to 1.78 in thirty females. A few measurements of the interocular distance and the distance between the inner edges of the antennal sockets have been made, but these are apparently not of diagnostic value.

Several other ratios were found to be variable. Thus in *P. pallens* total length/width varied from 2.69 to 3.21 in seventy-four males, and from 2.53 to 3.37 in thirty-one females. In six males of *P. ceratus* antennal length/total length varied from 0.38 to 0.45, and the ratio of the width across the eyes to the pronotal width varied from 0.64 to 0.75.

The degree of the divergence of the interocular margins in *Photinus* was also found to be quite variable.

Elytral color is variable, and a series of specimens of a species will show some gradation on both side of the color given in the descriptions, these gradations, sometimes at least, approaching overlap with those of other species. However, it is rather surprising how constant the elytral colors are in species in which a sufficient number of specimens have been available for study. Older cabinet specimens may have darkened considerably, while specimens defatted with benzene may be considerably lighter than those collected in alcohol.

Antennal form may vary in taper, compression, thickness of intermediate articles, etc. Some variations of this kind may be due to contraction in drying.

Legs, in general, show considerable variation in the extent and degree of pigmentation. The ratio of the length of the posterior legs to the total length varies in a manner similar to that of antennal length.

The shape of the pygidium may vary from nearly semicircular to markedly tridentate.

Explanate elytral margins may be concolorous with, or slightly lighter or darker than the ground color; this is distinct from the presence of a definite elytral border.

Species	Apparent elytral ground color	*Dictionary of Color* Plate	Column	Line
Photinus				
alticola	Brown (2)	8	E	11
amplus	Reddish brown (2)	13	J	9
blackwelderi	Yellowish (2)	11	F	5
brunescens	Reddish brown (2)	14	G	9
		14	I	8
ceratus	Pale tan (2)	8	H	12
		12	G	7
	(3)	12	F	7
commissus	Yellowish (2) (3)	12	F	6
		12	J	6, 7
elisabethae	Brown (2)	8	C	9
		15	A	8
euphotus	Reddish brown (2)	14	J	9, 10
evanescens	Dark brown (2)	7	A	11
		15	J	12
	Black (3) (5)	—	—	—
flavolimbatus	Brown (2)	8	H	12
		15	A	8
gracilobus	Pale tan (2)	12	F	6
leucopyge	Pale tan (2)	13	I	8
		12	G	6
lewisi	Brown (2)	8	J	10
		15	A	6
lobatus	Brown (2)	15	A	10
	(3)	11	E	3
lundi	Brown (4)	8	A	12
		15	A	8
lucernula	Reddish brown (2)	14	J	10
	(3)	15	C	11
melanopyge	Pale tan (2)	12	F	6
melanurus	Dark brown (2)	7	A	11
		15	A	8
naevus	Pale yellowish grey (1) (2)	17	B	1
nothus	Dark brown (2)	8	A	11
		16	A	12
pallens	Pale yellowish grey (1) (2) (3)	17	B	1
		15	J	12
synchronans	Dark brown (2)	7	C	11
		8	E	12
		15	A	7
	Black (3) (5)	—	—	—

Species	Apparent elytral ground color		*Dictionary of Color* Plate	Column	Line
variabilis	Brown	(2)	7	C	11
			7	E	11
xanthophotis	Dark brown	(2)	8	J	12
Diphotus					
bucki	Brown	(2)	8	E	11
			15	A	9
glaucus	Pale yellowish grey	(1) (4)	10	G–H	3
montanus	Brown	(2)	14	H	8
				J	10
		(3)	15	A	8
ornicollis	Pale tan	(2)	9	G	5
			11	J	5
Photuris					
jamaicensis	Pale yellowish male	(2)	14	B	7
				J	7
	female	(3)	12	G	5
			14	G	8

Table 1. Colors of some Jamaican Lampyridae. (1) = not well matched; (2) = collected by Buck, 1936, 1941; (3) = collected by McDermott, 1951, 1952; (4) = old specimen; (5) = not matched, too dark.

USE OF COLOR TERMS.—Owing to the difficulty of conveying in words one person's impression of a color so that a second person can visualize that color, it is desirable to have some standard of reference. The names of colors are by no means standardized. Thus, Torre-Bueno (1937) gives "brownish yellow" as a definition of three different words—fulvous, testaceous, and luteous. He defines fuscous as "dark brown approaching black," infuscate as "smokey grey-brown," and brunneus as "reddish brown." These definitions do not always agree with those of commercial dictionaries. Thus Funk & Wagnall's *Comprehensive Standard Dictionary* defines fuscous as "greyish brown, dusky, tawny," and the latter words as "tan-colored, brownish yellow," and fulvous as "reddish yellow."[4]

[4] (It may be noted that Circular 553 of the National Bureau of Stand-

As a guide to those who may have access to Maerz and Paul's *Dictionary of Color,* a number of typical Jamaican fireflies have been compared with the color plates in this book and the colors in the plates which appear to the eye (McD) to come closest to matching the elytral ground colors are tabulated below (table 1). The conditions of observation were those of general room illumination from north sky daylight, comparison being made by matching the elytra of a pinned specimen against the unit colors as a background. Alternative color units are given for some species where the match appears to be equally satisfactory with different units. Some of the specimens were compared on days some months apart, and either the same or adjacent units found to match.

In the descriptions of the species given herein, the words fuscous, infuscate, testaceous, and piceous have been avoided as far as possible, and usually occur only when part of a description is copied from the original. Infuscation is used in the sense of an indefinite darkening.

Apterous Females.—In many species of fireflies the wings and elytra of the females are rudimentary or even completely absent. This is obviously the result of degeneration, regardless of the genetic mechanism resulting in the loss. It has been noted that species living in regions where the prevailing winds would act to blow the insects away from areas suitable for reproduction of the species are likely to develop apterous females; this, however, does not explain the situation for many species, such as the European glowworms, the North American *Photinus scintillans,* and *Phengodes.* In many species of *Photinus* the females, though alate, fly but little and it would be an easy step from this condition to complete non-use of the wings and eventually to their loss. Barber made the following unpublished note on the subject, referring particularly to the species collected in Jamaica. " Correlation of the sexes by the collector in the field or by the taxonomist in the museum is more or less fortuitous unless actual coition is observed and the pair preserved

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ards, *The ISCC—NBS Method of Designating Colors and a Dictionary of Color Names* (Washington, 1955) indicates that a quite wide range of shades and tones may be covered by a single color name.)

with notes and as an unmixed sample. In many species both sexes fly together at the same time and are so similar that no one doubts their identity, but in many other species the collector secures only the males, or accidentally secures flightless females which are so dissimilar from their males that they may appear in the laboratory to be associated with the males of two or more species."

"The degeneracy of the females seems to be specific rather than common to groups of species, since closely related forms may have fully winged or degenerate and completely apterous females, but no case of gradational degeneracy of females belonging to a single male is known. An apterous physogastric female collected in 1941 at Mandeville raises doubt if the normally winged female collected at the same place in 1936 was correctly associated with the type of *Photinus amplus* which was collected at Mandeville in 1919, since both females display certain similarities to the male. Five other species of apterous females and a few other flightless species are before me, the most conspicuous being *Jamphotus* (4 specimens, no male known) and the two females associated with the male type of *Diphotus darlingtoni.*"

Since Barber wrote the above note, an apterous physogastric female was found among the specimens at the Institute of Jamaica. It was collected at Corn Puss Gap, St. Thomas Parish, about February 14, 1950, altitude about 1500 ft., and is quite certainly the female of *Photinus euphotus;* this suggests that the apterous specimen collected at Mandeville in 1941 is probably *euphotus.* It is entirely possible that some species may have dimorphic females, and perhaps the possibility of seasonal varieties should not be overlooked.

In connection with apterous females of Jamaican species, an interesting question arises as to whether the degenerate condition has developed relatively recently on the Island from a species in which the female was formerly winged, or whether the apterous condition was a primary character in some species formerly common to Jamaica and the continent where there was a possibility of a land connection between them. This problem is, of course, insoluble at present, unless some continental form can

be identified with a Jamaican species, which seems quite unlikely for any of the known species from the Island.

The following key is based primarily on that of Barber (1941), modified so as to include the species described by Buck (1947) and the two new species of *Diphotus* described herein. While a strictly dichotomous key would perhaps have been preferable, attempts to devise such a key resulted in a rather cumbersome arrangement, and it is believed that the system adopted will prove easier to use. As far as possible the characters given by Barber have been retained and modified only as later information has made necessary. The key is based on the characters of the males, except where only the female is known. The separation of *Jamphotus* at 3 C is admittedly awkward and is included only to allow the listing of this remarkable apterous female.

The separation of the several species of *Photinus* and *Diphotus* is based largely on elytral color and body size, other characters, such as elytral borders and margins, scutellum and mesonotal plates, tergite and sternite coloration, etc., being added as distinctive. The use of the elytral coloration as a main factor may be criticized on the ground of the recognized variability of this character. As applied to the known Jamaican species of *Photinus* and *Diphotus,* however, this character seems to be sufficiently constant intraspecifically to warrant its use. Since the elytra represent about eighty per cent of the total area visible from above (except in apterous females) this is the most easily recognized character. However, it is not the intention of the present authors to leave the impression that they believe the elytral colors are as described in all specimens of a species, but only that the normal variation permits the grouping given when other characters are considered. In any case, final determination will usually require reference to the detailed descriptions.

The species which come into the groups of reddish brown, brown, and dark brown require particular care, as some of them are very similar in general appearance and in some cases can only be separated on the basis of the aedeagal structure.

Of the twenty-nine primary species of *Photinus* herein recognized, only eleven have specific characters admitting of fairly

easy immediate identification. These are:

P. amplus; reddish brown color, elliptical outline, and pale tergites (cf. *P. euphotus* below).

P. blackwelderi; pale yellow color and longitudinal elytral vittae, about 8 mm. long (cf. *P. chapini* and *P. commissus* below).

P. chapini; much like *P. blackwelderi* but smaller, about 6 mm. long.

P. commissus; yellow color and distinctive elytral pattern of curved vittae.

P. euphotus; reddish brown elytral color and narrowly elliptical outline, similar to *P. amplus,* but usually somewhat larger and tergites infuscate.

P. lucernula; reddish brown color and elliptical outline similar to *P. amplus* and *P. euphotus,* but smaller, luminous organs of male cover only median portion of sternites 6 and 7, eyes proportionately large.

P. lundi; dark brown, relatively very large eyes resulting in pronotum usually being widest at apical third, body rather narrow.

P. naevus; very pallid, with dark spots at bases of elytra, and typically with 4 irregular spots on pronotum, smaller than the similarly colored *P. pallens* below.

P. pallens; large size, very pallid, no elytral spots, typically with a spread-eagle pattern on the pronotum, ubiquitous.

P. pardalis; spotted elytra, a unique character among known Jamaican lampyrids.

P. xanthophotis; large size, up to 20 mm. long, dark brown, somewhat purplish, elytra.

Of the fourteen species of *Diphotus, D. unicus* is easily identified by its small size and ivory and yellow pronotum, and *D. caputdelphini* n. sp. by its uniformly black color. *D. darlingtoni, D. ornicollis,* and *D. semifuscus* are also fairly distinctive.

KEY TO THE SPECIES OF JAMAICAN LAMPYRIDAE

1. A All tarsal claws simple 2
   B Anterior claw on each tarsus bifid or cleft at apex
   Photuris LeConte 1851 ... 5
   C Both claws on all tarsi bifid
   Presbyolampis (Buck, 1947) ... 35C

2. (1A) A Luminous organs of male on sternites 6 and 7 3
   B Luminous organs of both sexes on sternite 8 4

3. (2A) A Sternite 8 of male bilobed, frequently retracted so that only the 2 rounded lobes project beyond the apices of the 7th; aedeagus with lateral lobes of diverse forms but apically descending below the tip of the median lobe, which usually curves upward between them (see Pl. X, fig. 85b); luminous organ of female on sternite 6 only
   Photinus Laporte 1833 ... 5

B Sternite 8 of the male longer, less emarginate; aedeagus more compact, subcylindrical, the lateral lobes short, contiguous dorsally at apices above the longer projecting median lobe; lateral edges of pronotum reflexed; luminous organs of female on sternites 6 and 7, but area less than in male ..... *Lecontea* (E. Olivier, 1899) (*Pyractomena* Leconte, 1851) ... 35B

C Large female with rudimentary elytra; dorsum of abdomen bears 4 rows of tubercles; male unknown *Jamphotus* (Barber, 1941) ... 35A

4. (2B) A Lampyrids of usual proportions, i.e., 5 to 20 mm. long and 2 to 7 mm. broad; pronotum modified semi-elliptical in outline; 2 oval luminous organs lateral on sternite 8 *Diphotus* (Barber, 1941) ... 36

B Very small, usually less than 5 mm. long, body subcylindrical and very narrow; pronotum subquadrate *Microdiphot* (Barber, 1941) ... 50

5. (3A) A Luminous area of male occupying all of sternites of the 6th and 7th abdominal segments 6

B Luminous organs of the male reduced in width, occupying only median half or third of sternites 6 and 7; very large eyes; elytra somewhat reddish medium brown *Photinus lucernula* Barber

6. (5A) A Elytral ground color very pale, unornamented, but may show basal darkening 7

B Elytral coloration otherwise 8

7. (6A) A Larger, 12 to 19 mm. long ..... *Photinus pallens* (Fabr.)

B Smaller, 8 to 12 mm. long; elytra with small dark areas near base ..... *Photinus naevus* Barber

8. (6B) A Elytral ground color pale or yellowish, with vittae or maculae 9

B Elytral coloration otherwise 12

9. (8A) A Elytra with definite, relatively straight, longitudinal vittae 10

B Elytral coloration otherwise 11

10. (9A) A Larger, about 8 mm. long .... *Photinus blackwelderi* Barber

B Smaller, 5 to 6 mm. long ..... *Photinus chapini* Barber

11. (9B) A Elytra with a pattern of curved vittae *Photinus commissus* E. Olivier

B Elytra with relatively large, irregularly distributed maculae *Photinus pardalis* Buck

12. (8B) A Elytral ground color pale tan or very light greyish brown, usually darkened basally 13

B Elytra darker 16

13. (12A) A Tergites and sternites all pale 14

B Sternites 2 to 5 infuscate in varying degree 15

14. (13A) A Smaller, 6 to 8 mm. long, usually with diffuse pronotal infuscation ..... *Photinus morbosus* Barber [5]
B Larger, 8 to 10 mm. long, usually with little or no pronotal infuscation ..... *Photinus ceratus* Leng and Mutchler [5]

15. (13B) A Larger, usually 7 to 8 mm. long; tergites all somewhat infuscate; 5, 6, and 7 have long, lateral, posteriorly projecting points; pygidium black ..... *Photinus gracilobus* Barber
B Smaller, 4.5 to 6.5 mm. long; tergites 1 to 7 dark; pygidium pale to black; sternite 5 may be partly pale *Photinus leucopyge* Barber [6]

16. (12B) A Elytra medium or reddish brown 17
B Elytra darker 24

17. (16A) A Outline somewhat elliptical; elytra with wide explanate margins 18
B Sides parallel or nearly so 21

18. (17A) A Tergites all dark 19
B Tergites all pale 20

19. (18A) A Larger, about 12 to 14 mm. long:
Sternites 2 to 5 very short, mainly brown, may be medially paler ..... *Photinus euphotus* Barber
Sternites 2 to 5 not shortened, strongly infuscate except median fourths paler; eyes smaller *Photinus euphotus cinchonae* Barber
B Smaller, 7 to 9 mm. long; proportionately larger eyes; luminous area in male reduced .... *Photinus lucernula* Barber (see couplet 5 B)

20. (18B) A Sternites 2 to 4 dark, 5 one-half or more pale; 12 to 14 mm. long ..... *Photinus amplus* Barber

21. (17B) A Mesonotal plates pale 22
B Mesonotal plates brown 23

22. (21A) A Larger, about 12 mm. long; tergites usually all dark, but posterior 3 may be paler; sternites 2 to 4 brown, 5 white except lateral sixths brown .. *Photinus brunescens* Barber
B Smaller, 6 to 8.5 mm. long; tergites all brown, but anterior 3 or 4 may be lighter; sternites 2 to 5 brown; pronotum usually widest at apical third to accommodate the very large eyes ..... *Photinus lundi* Barber

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[5] There is no definite structural character on which these two species can be separated. The separation at 8 mm. length is arbitrary and the aedeagi are similar. The flashing conduct of the males is apparently different.

[6] Barber originally separated the specimens of this group in which the pygidium was dark brown to black, as *Photinus melanopyge* (Type No. 55621, U.S.N.M.). He concluded later that *melanopyge* was a synonym of *leucopyge,* and we are so treating it here.

23. (21B) A Very small, less than 5 mm. long; pronotum yellow; tergites 1 to 4, 5, or 6 dark, others paler; sternites 2 to 4 dark, 5 mostly pale ..... *Photinus harveyi* Buck

24. (16B) A Elytra dark brown 25

B Elytra black or nearly so in life (old or defatted cabinet specimens may be dark brown instead of black) 30

25. (24A) A Mesonotal plates brown 26

B Mesonotal plates white or pale 29

26. (25A) A Elytra with pale borders 27

B Elytral borders not pale 28

27. (26A) A Tergites 1 to 4, 5, or 6, dark, others pale (occasionally all tergites may be rather pale); sternites 2 to 4 dark, 5 usually partly white; 6 to 7 mm. long:

Narrow, about 2 mm. wide .. *Photinus alticola* Barber [7]

Broader, 2.6 to 3 mm. .. *Photinus flavolimbatus* Barber [7]

B Somewhat larger, 8 to 8.5 mm. long; pronotum yellow with brown spot; elytral borders about ⅓ of elytral width; tergites and sternites as in A above

Photinus elisabethae Buck

28. (26B) A Larger, 8 to 10 mm. long; tergites 1 to 5 or 6 brown, others pale; sternites 2 and 3 light brown, 4 partly and 5 mostly white ..... *Photinus lobatus* Barber [8]

B Smaller, 6.5 to 8 mm. long; tergites 1 to 7 brown, 8 pale or white; sternites 2 to 5 brown, 5 may have a white apical edge ..... *Photinus lewisi* Buck

29. (25B) A Elytra without pale borders (no known species of *Photinus* in Jamaica with white or pale mesonotal plates has pale-bordered elytra):

Very large, 18 to 20 mm. long; subparallel; elytra have a purplish cast; sternites all rather pale in some specimens ..... *Photinus xanthophotis* (Gosse), *Photinus xanthophotis catherinae* Barber [9]

B Smaller, about 11 to 12 mm. long, 4 to 6 mm. broad; tergites and sternites all pale; lateral elytral punctures confused

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[7] These two rather similar species have different aedeagi (see Pl. VII, fig. 70 and Pl. XI, fig. 92).

[8] Originally described by Barber as *Photinus lobatus lobatus,* with two sub-species which we now regard as varieties. The retention of the trinomen does not seem warranted, and Barber had abandoned it in his later notes. The varieties are:

Sternite 5 pallid with baso-lateral areas more or less faintly infuscate; aedeagus shorter ..... *Photinus lobatus* var. *obscurellus*

Sternite 5 usually wholly black; aedeagus more attenuate

Photinus lobatus var. *rapidus*

[9] The females of *P. x. catherinae* have the elytra long, covering the abdomen, those of the female of *P. xanthophotis* are shorter. The males appear to have no visible distinguishing character.

and not forming a distinct sulcus (cf. *P. synchronans*, below); elytra perhaps black in fresh specimens
Photinus hypoleucus Barber

C Small, 8 to 11 mm. long; tergites laterally pale, but at least the posterior 5 have a brown median carina; sternites 2 to 5 light brown, but may be laterally pale
Photinus variabilis Barber

30. (24B) A Elytra without pale borders 31
B Elytra with pale borders 34
31. (30A) A Mesonotal plates white 32
B Mesonotal plates brown 33
32. (31A) A Tergites all black, pygidium may be laterally pale; sternites 2 to 4 brown to black, 5 at least medially pale, and may be pinkish laterally; 8 to 11 mm. long, usually 9+ mm.
Photinus melanurus Barber

B Tergites all pale to light brown, posterior ones tending to be darker; pygidium pale, or lateral thirds brownish; sternites 2 to 4 light brown, 5 partly white; lateral elytral punctures form a distinct sulcus (cf. *P. hypoleucus*, above); 7.5 to 10 mm. long, usually less than 9 mm.
Photinus synchronans Barber

33. (31B) A Small, 6.5 to 7.5 mm. long; tergites 1 to 3 pale, 4 to 7 brown; pygidium laterally pale; sternites 2 to 4 dark, 5 usually medially white ... *Photinus evanescens* Barber [10]
34. (30B) A Very small and narrow, 5 to 5.5 mm. long and 1.8 to 2.0 mm. broad; tergites 1 to 7 dark brown to black; 8 may be lighter laterally and apically; sternites 2 to 4 dark brown, 5 partially white ..... *Photinus nothus* Barber

B Superficially very similar to the above species, but differentiated by the aedeagus (see figs. 71, 91, Pls. VII, XI)
Photinus nothoides Buck

35. (3C) A Large apterous female, 17 mm. long, with rudimentary elytra; sternite 7 pale, with luminous organ (see detailed description by Barber 1941)
Jamphotus tuberculatus Barber

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[10] Originally described by Barber (1941) as *P. evanescens evanescens* with 3 subspecies, which we now regard as varieties, a view which was expressed by Barber in his later notes. The retention of the trinomen does not appear justified. This species is widely distributed in Jamaica and is apparently subject to considerable local variation. A complete series of forms intermediate between the following varieties could probably be collected (see Buck, 1942).

Slightly larger, 7 to 8 mm. long; tergites 6 to 8 pale
Photinus evanescens var. *dubius* (see note in description of this species)

Smaller, 6 to 6.5 mm. long; posterior tergites somewhat brownish
Photinus evanescens var. *moneague*

Tergites 6 and 7 brown; pygidium pale or basally brownish
Photinus evanescens var. *montego*

35. (3B) B Ochreous, with a pair of entire, closely approximate medial pronotal vittae basally joining a pair of abbreviated basolateral vittae; discal elytral infuscation divided into a broader submarginal vitta, a narrow median, and a narrower sutural vitta by the ochreous costae; about 8 mm. long ..... *Lecontea gamma* (J. Duval)

35. (1C) C Photogenic organs occupying only median half to third of abdominal sternites 6 and 7 (cf. *Photinus lucernula*); sternite 8 with long slender point projecting from middle of posterior margin; pronotum conspicuously short; elytra uniform dark brown to black, with very narrow lateral and sutural white borders; aedeagus different from any other known Jamaican firefly; 8 to 8.5 mm. long *Presbyolampis immigrans* Buck

36. (4A) A Aedeagus long, 3 mm., attenuate (e.g., Pl. V, fig. 58) 37

B Aedeagus shorter (e.g., Pl. V, fig. 61) 38

37. (36A) A Larger, about 10 mm. long; pronotum conspicuously tumid on each side of the median sulcus; pronotal disk and elytra very dark, their margins and suture pale; male with sternite 9 apically widened and distorted, its apex narrowed and armed dorsally with a pair of recurved hooks; aedeagus unusually long, 3 mm., narrow and apically attenuate ..... *Diphotus bucki* Barber

B Smaller, 8 mm. long; pronotum with dark brown semi-circular disk surrounded by white border; elytra light brown with white borders, nearly parallel; tergites 7 and 8 are broader than the corresponding sternites; sternite 9 greatly elongated, with dark recurved hooks and large muscles on the internal surface, as in *D. bucki;* aedeagus identical in shape, structure, and size with that of *D. bucki* ..... *Diphotus masti* Buck

38. (36B) A Elytra light yellowish brown, or light tan 39

B Elytra darker 40

39. (38A) A Smaller, about 7.5 mm. long; scutellum and mesonotal plates brown; elytra with longitudinal vittae *Diphotus darlingtoni* Buck

B Larger, 11 to 12 mm. long; outline narrowly elliptical; scutellum white; mesonotal plates brown; no elytral vittae or pale borders; (occurrence in Jamaica doubtful) *Diphotus glaucus* (G. A. Olivier)

40. (38B) A Elytra light or greyish brown 41

B Elytra yellowish 42

C Elytra darker 43

41. (40A) A Pronotal marking of 2 small spots; tergites 1 to 5 light brown, 6 and 7 darker; pygidium very dark brown to black; 10 to 11 mm. long ..... *Diphotus ornicollis* Barber

B Two large pronotal spots separated by pale strip and sulcus; tergites 1 to 5 pinkish and brown, 6 and 7 brown; pygidium half pale and half black; elytra greyish with wide lateral and narrow sutural borders; the latter together with the scutellum and pronotal stripe give a long, light, median line; 7 to 12 mm. long, usually about 10 mm.
Diphotus montanus Barber

42. (40B) A Elytra with broad longitudinal brownish vittae; pronotum with 4 irregular brown vittae; about 5.6 mm. long
Diphotus farri n sp.

43. (40C) A Elytra reddish brown 44
B Elytra darker 45

44. (43A) A Scutellum and mesonotal plates dark brown; tergite 7 black with narrow, pale apical margin; sternite 7 with median apical point; outline somewhat oval; no marked elytral vittae, but explanate margins wide, about ⅓ of elytral width at middle; pronotum approximately semicircular, disk medium to dark brown, with wide lateral and apical and narrow basal borders white; 7.5 mm. long
Diphotus dahlgreni Buck

B Scutellum white or pale; mesonotal plates light brown, medially paler; tergite and sternite 7 black; elytral outline subparallel; short, indefinite medium brown vitta on each elytron, widened basally; explanate margins about ¼ of elytral width at middle; pronotum rather longer than semicircular, with wide, shallow median sulcus in basal half in a pale streak, on each side of which is a brown area about 1 mm. long, the apical ends of which are approximately concentric with the apical margin; remainder of pronotal surface pale or yellowish; 7 to 9 mm. long
Diphotus pantoni (E. Olivier)

45. (43B) A Elytra medium brown 46
B Elytra darker 47

46. (45A) A Pronotum mainly yellow; sternites 2 to 7 brown; 10 to 12 mm. long ..... *Diphotus semifuscus* Barber

47. (45B) A Elytra dark brown to nearly black 48
B Elytra distinctly black 49

48. (47A) A Pronotum yellow to orange, with no dark spot; small, 5 to 8 mm. long ..... *Diphotus unicus* (Mutchler)

B Pronotum with large transverse black area; elytra bordered pale yellow; 7.6 mm. long
Diphotus flavomarginatus Barber

C Elytra and pronotal disk very dark brown, with broad pale yellow borders; scutellum white; mesonotal plates black; body uniformly dark brown; tergite 8 pale in apical two-thirds; 8 mm. long ..... *Diphotus lucivolans* Barber [11]

[11] Only the female of *D. lucivolans* is known. It is very similar to female of *D. flavomarginatus*.

49. (47B) A Pronotum black; elytra black with brilliant white borders; may have a metallic bluish luster; 7 mm. long
Diphotus caputdelphini n. sp.

50. (4B) A Very small, 3.5 mm. long; abdomen mostly pale; elytra dark brown, very slender, minutely asperate, with very narrow sutural margin; outer margins deflexed and not expanded; tergites 1 to 3 white, 4 to 6 pale brown; sternites all white or pale .. *Microdiphot cavernarum* Barber

B Somewhat larger, 4.6 to 5.3 mm. long; abdomen mostly black; elytra black with narrow white lateral and sutural borders, and tapering in basal fourth and apical fifth; slightly dehiscent from mid-length to apices; tergites all brown, darkening progressively posteriorly; sternites 2 to 7 brown, darkening progressively
Microdiphot barberi Buck

51. (1B) A Pale, yellowish; each elytron with two tapering and posteriorly obsolescent vittae, which are sometimes very short; elongated discal pronotal spot; both sexes similar with sternites 6 and 7 luminous
Photuris jamaicensis E. Olivier (1886)

The Use of the Aedeagus as a Specific Character.—In the classification of species we make the fundamental assumption that the morphology of the internal male copulatory apparatus, the aedeagus (following Sharp and Muir, 1912), is the most reliable indicator of affinity or separation. This assumption is generally supported by not only important structural characters, but by field observations on distribution, behavior, habitats, etc. Differences in the form of the aedeagus strikingly confirm differences between species postulated on other grounds. On the other hand, similarity in aedeagal structure occasionally allies species which show considerable divergence in less fundamental characters such as coloration. It is fortunately true that clear morphologic differences usually accompany these other specific differences, but in a few instances we have been compelled to consider both the possibility of a single species showing a range of morphologic variation rather wider than is usually recognized, and conversely the possibility of two different species being nearly indistinguishable on structural grounds. Buck (1947) said, ". . . the aedeagus is no less variable than most other structures, and indicates that too much importance should not be attached to minor variations in contour."

It is probable that the ultimate criterion of the relation of the aedeagal structure to specific entity is whether a variation is sufficient to prevent successful mating—with which must be considered other factors such as possible specific odors, differences in habitat, season, etc., and in the case of the fireflies, the pattern and mode and color of the light-emission. In the examination of a large number of Buck's specimens only one apparent hybrid was encountered; this seemed to be *Photinus naevus* × *P. ceratus*, having some of the characters of both and a defective aedeagus.

As an example of similarity of aedeagal structure, the case of *Diphotus bucki* and *D. masti* may be cited. In these species the aedeagus is of the same form and absolute size, although in body size and other characters the two species are quite distinct. Again, the aedeagus of *Photuris jamaicensis* is strikingly like that of *P. versicolor* and other North American species (see Barber, 1951), the only apparent difference being that in the Jamaican species the lateral processes are slightly curved. On the other hand, the externally very similar species *Photinus flavolimbatus* and *P. alticola* have rather easily distinguished aedeagi.

There are, of course, some puzzling cases. *Photinus commissus*, a very common and widely distributed Jamaican species, quite constant in pattern of luminosity and generally fairly so in the elytral markings, though subject to a somewhat wider range of color variation than most species, appears to have four somewhat different variations of aedeagal structure. *P. amplus* shows two variations in this character. Barber (1941) remarks that *P. lucernula*, *P. euphotus*, and *P. e. cinchonae* ". . . agree in genitalic and some other structures and should form a separate genus. . . . *Photinus amplus* is superficially like, but not congeneric with *euphotus*." In the present writers' opinion these aedeagal differences do not appear to be sufficient to warrant removing these species from *Photinus*, unless it is desired to break up this large genus into several smaller ones. The general similarity of the aedeagi in *Photinus ceratus*, *P. gracilobus*, *P. leucopyge*, *P. lobatus*, and *P. morbosus* seems to indicate a close relationship between these species with *P. harveyi* possibly belonging in this group also.

Aedeagal differences between genera are usually sufficiently marked so as to cause no confusion. The aedeagi of the various species of *Photinus* are all modifications of the same basic type of structure. Those of *Diphotus* are modifications of another basic design.

In the case of the aedeagus, as with other structures, "One picture is worth 10,000 words," and we have therefore made drawings of this organ for all of the species for which it is available. It may be noted that the aspect of the aedeagus as viewed from above is ventral during coitus, and any consideration of the mechanism involved must take into account this inversion. Plates IV to XIII show the aedeagus as in its normal position in the abdomen.

The species of *Photinus* and *Diphotus* are listed below in groups which appear to be most closely related on the basis of aedeagal similarity (table 2).

Methods for the Examination of the Terminalia.—Buck (1947) has described Barber's method for the examination of the male genitalia in fresh specimens as follows: "Place the specimen alive in at least 10 volumes of 70 percent alcohol and leave for several days or longer; extend the abdomen and hook out the aedeagus with a bent-tipped micropin so that both surfaces are fully displayed (if it becomes detached, cement on a hair and mount with the specimen); place in 95 percent alcohol, one hour; absolute alcohol (2 changes) overnight to several days; benzene, 10 minutes; allow to dry on porous tile or filter paper; mount on point with cellulose acetate cement diluted with amyl acetate."

The hooked pin may be prepared by bending the point of a #0 or #1 pin against a glass surface. Only a very small hook is necessary and it may be well to provide several such hooks, some with merely a 90° angle. The hook is inserted under the ventral side of the pygidium sufficiently deeply to engage the basal end of the aedeagus and then pulled gently so as to draw out the aedeagus. Complete extraction is usually not necessary for identification purposes.

For dried cabinet specimens the same method may be used

Species	Pl.	Fig.
Photinus:		
ceratus	X	86
gracilobus	XII	94
leucopyge	XI	89
lobatus	X	84
morbosus	X	87
harveyi ?	VII	69
lundi	VIII	76
naevus	VIII	74
chapini	XI	90
elisabethae	XI	88
hypoleucus	IX	78
synchronans	VII	72
evanescens	IX	79
lewisi	X	85
pardalis	X	83
amplus	IX	80
xanthophotis	IX	82
brunescens	VIII	73
melanurus	VIII	75
variabilis	VIII	77
blackwelderi	VII	68
commissus i to iv	XIII	98 to 101
alticola	VII	70
nothoides	VII	71
flavolimbatus	XI	92
nothus	XI	91
euphotus	XII	96
lucernula	XII	97
pallens	VI	65
Diphotus:		
bucki	V	58
masti	IV	52
dahlgreni	IV	55
montanus	V	61
ornicollis	IV	56
farri	XII	93
caputdelphini	XII	95
semifuscus	IV	53
unicus	IV	54
darlingtoni	V	57
pantoni	IV	51
flavomarginatus	VI	67

Table 2. List of groups of related species in the genera *Photinus* and *Diphotus* based on aedeagal similarities.

after keeping the specimen in a moist chamber for a few hours, or after soaking in a softening solution for which "ST–37," a proprietary antiseptic consisting of 30% glycerol with 1:1000

of hexylresorcinol, or even 25% alcohol may be used. In any case, the specimen may be remounted after passage through increasing strengths of alcohol, finishing with benzene, if desired, and drying.

The minute size of the aedeagus and its rather rigid structure makes mounting separately a rather simple matter. After extraction it may be placed in a relatively large volume of 95% alcohol for a few minutes, then for a similar period in pure acetone, dried in the air for a minute or so (at a room temperature of about 70° F.), and mounted directly on a bristle, fiber, or nylon filament with Duco or similar cement. A minute drop of the cement is applied to the tip of the filament and quickly placed in contact with the basal end of the aedeagal specimen, the cement allowed to set for a few minutes, and the fiber then cemented to a small card or point. After drying this may be labeled and pinned.

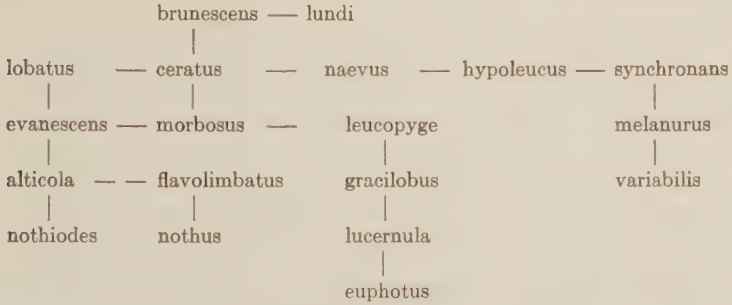
Some practice is desirable to acquire the " feel " of the operation. If the specimen is too soft the abdomen may tear at a suture, and it may be found best to hold the abdomen with a pair of fine forceps at segment 7. Specimens freshly killed by cyanide or ethyl acetate may be allowed to dry somewhat and then dissected at once, or after treatment with 70% alcohol.

Green (1949, p. 54) gives another procedure for the extraction of the aedeagus which involves less danger of destroying the posterior abdominal segments.

Species Complexes.—The groups of very similar and presumably closely related species, species complexes, frequently encountered among insects, are apt to prove very troublesome to the taxonomist and the fireflies are by no means an exception. There are several of these groups of closely related species among the Jamaican lampyrids, some of the most notable being those composed of (1) *Photinus lobatus* and *P. evanescens;* (2) *P. melanurus* and *P. variabilis;* and (3) *P. euphotus, P. lucernula,* and *P. gracilobus.* In the first of these groups, typical specimens of the two species would not be readily confused on body size alone, but both have a rather wide range of variation in this factor. Intermediates between the varieties (Barber's subspecies) of *P. evanescens* are found which adds to the

difficulties in this group. In the second group the aedeagi of the two species are very similar and although superficially the typical forms are not easily confused, both show variations approaching the other species. Barber's (1941, p. 2) discussion of the third group has already been cited.

On the basis of aedeagal similarity and superficial resemblance, a large number of the species of *Photinus* may be considered as belonging to a group centering around *P. ceratus*, taking the latter largely as a matter of convenience rather than for any technical reason. The variations in the aedeagus in this group lead to the arrangement shown below which, however, should not be construed as indicating the course of phylogenetic derivation, or necessarily the closest relationship.


brunescens — lundi
lobatus — ceratus — naevus — hypoleucus — synchronans
evanescens — morbosus — leucopyge — melanurus
alticola — flavolimbatus — gracilobus — variabilis
nothiodes — nothus — lucernula — euphotus

This grouping is due largely to the fundamental aedeagal pattern of *Photinus*, and it is easy to add to the group other species such as *lewisi, elisabethae, pardalis, blackwelderi, chapini*, etc. In the above arrangement the three species *lobatus, ceratus*, and *naevus* are of approximately the same size, 8 to 12 mm. long; *naevus* is very pale, "white," *ceratus* is pale or light tan color, and *lobatus* dark brown; their aedeagi are of the same general type (figs. 74, 84 and 86), but sufficiently distinct to be specific. In the group *morbosus — leucopyge — gracilobus* the insects are of much the same pale tan color as *ceratus*. The aedeagi of the first two are very similar, that of *gracilobus* is somewhat different and suggests relationship to the otherwise quite different *P. lucernula*, and through the latter to the larger *P. euphotus*. Of this series, *morbosus* is scarcely distinguishable from *ceratus*

except arbitrarily on body size; *leucopyge* is fairly easily distinguished from *morbosus*. *P. naevus* and the very uncommon *P. hypoleucus* hardly form a complex, and while the latter has some aedeagal resemblance to *P. synchronans,* it is a considerably larger insect and would not normally be confused with *synchronans* on other characters. *P. synchronans* and *P. melanurus* are superficially rather similar, the latter averaging a little larger, but the aedeagi are distinctly different and little confusion is apt to occur. The aedeagal resemblances lead from *evanescens* through *P. alticola* to *P. nothoides,* while *alticola* bears a considerable superficial resemblance to *P. flavolimbatus* in which the aedeagus is similar to that of *P. nothus,* making a somewhat peculiar grouping of these four species.

IV. Descriptions of the Species

In the following pages is given a description of each species of lampyrid firefly at present recognized as occurring in Jamaica. For the most part these descriptions have been prepared from specimens in the collections of the U. S. National Museum, mainly those collected by Buck in 1936 and 1941, and usually from types or paratypes. In all cases the types of Barber's and Buck's species have been examined. The data given by Barber (1941) and Buck (1947) have been included where applicable. Some species are represented by only a very few specimens and some are uniques, hence allowance must be made for some degree of divergence from the characters as given. It has also been noted that in several cases the colors of old cabinet specimens have darkened considerably. On the other hand, fresh specimens of some species taken in 1951–1952 were definitely darker than specimens in the U. S. National Museum. When known, these conditions have been noted in the descriptions. The aedeagi have been treated separately and are included in the descriptions only by reference to the figures showing them. The patterns of light emission and mating signals, when known, are also treated separately, as is also the general distribution of the species in the Island, in the later sections.

It will be understood that in the males of *Photinus* the 6th and 7th abdominal sternites are pale and luminous in life. In the

females the 6th sternite is usually the site of the only luminous area. In *Diphotus* and *Microdiphot* both sexes (when the female is known) have the luminous organs on the 8th sternite. In *Photuris* sternites 6 and 7 are luminous in both sexes, but the active area is somewhat reduced in the females.

In the general descriptions the following arbitrary classification for size has been adopted. Very small—average length 5 mm. or less; small—average of usual range of length, 5+ to 9 mm.; medium—average of usual range of length, 9+ to 13 mm.; large—average of usual range of length, 13+ to 17 mm.; very large—over 17 mm. long. These average lengths are for the males; the females are usually slightly larger. The actual range of variation in length will, of course, overlap the above groups in some instances.

In the examination of specimens with a binocular microscope at 10× to 30× magnification and the usual brilliant oblique illumination, the colors are apt to appear somewhat lighter than in direct examination. Specimens killed and preserved in alcohol may also present a somewhat different appearance from those killed by cyanide and then dried.

In the descriptions in reference to the elytra the word "border" has been used in connection with coloration only, in contradistinction to "margin" which is used for the usually more or less explanate structural feature; the two may or may not coincide. Tergite and sternite colorations involve gradations of shade from practically white to actually black. In several cases the tergites and/or the sternites may show increasing or decreasing degrees of pigmentation in numerical order from the base. In *Diphotus* there is a tendency for sternite 7 to be black or nearly so, making a striking contrast with the very pale, luminous 8th segment.

Perhaps something should be said in regard to the terms used in describing the shape or outline. Published descriptions frequently say "oblong" or "oval" in reference to the body outline from the dorsal aspect. Actually neither of these terms is strictly accurate, at least as applied to the Jamaican lampyridae. When the lateral edges of the elytra are parallel or practically so, "oblong" may be accepted, but none of the Jamaican spe-

cies can be said to be " oval " in the sense of being wider across the elytra distinctly posteriorly to the midlength or, conversely, narrowing from the base of the pronotum to the elytral apices. For the usually so-called oval form, in which the maximum width is at or near the midlength, elliptical would be a more accurate term, modified as required by broadly, narrowly, short, or long.

The term scutate or scutiform, as applied to the outline of the pronotum, has been avoided in these descriptions. Actually, the outline is usually that of a semi-ellipse, the base of the pronotum being the minor axis, but occasionally the outline is more nearly semicircular, parabolic, ogival, or otherwise modified. In a long series of specimens of the same species it will frequently be found that no single term will be generally applicable for the outline of the pronotum; also that while the postero-lateral angles may be developed to approximately the same degree in all specimens of a species, there may be considerable difference in the slope of these angles with reference to the base or to the median lines.

Photinus alticola Barber

Barber, 1941, Proc. Rochester Acad. Sci. 8: 7.

Description prepared from Buck's specimens Nos. 475 and 484.

A small, slender, dark brown lampyrid with rather wide white elytral borders and a rectangular brown spot on the pronotum. Size, 6.0 to 6.5 mm. long, 1.9 to 2.0 mm. broad. (One specimen 5.5 mm. long is recorded.)

Pronotum 1.1–1.15 × 1.6–1.7 mm. Outline parabolic; opaque white, darkened over eyes; narrow complete but indistinct white border; rectangular brown spot about 0.6 × 1.0 mm., which may not be completely pigmented; slightly warty; only a trace of sulcus.

Scutellum dark brown; mesonotal plates brown.

Elytra 4.9–5.25 × 0.95–1.0 mm.; sub-parallel; dark brown with a distinct white border 0.25 mm. wide, and narrow white line at suture, neither extending quite to apex; narrow explanate margins, somewhat widened in basal fourth, and ending at about apical fourth; no obvious costae.

Frons brown, shining, warty; interocular margins slightly divergent; width across eyes 1.1 mm.; eye length 0.55 mm. Clypeus semicircular, brown with white edge. Mandibles small, 0.25 mm. across in closed position, but appear a little thicker than expected for so small an insect.

Maxillary palpi brown; labial palpi small, light brown.

Antennae 2.25 mm. long; brown, no white visible; third article longer than others except first.

Thorax ventrally brown.

Tergites 1 to 7 brownish, 9 pale.

Ventral abdominal segments 2, 3, and 4 brown, with sinuate posterior margins; apical half of 5 white; 6 and 7 luminous, longer than 5; 8 white; 6, 7, and 8 emarginate; 9 triangular, white.

Legs brown, femora lighter than tibiae, and tarsi darker; lobes of 4th tarsal article reach the small brown claws; tibial spurs, if present, very inconspicuous.

Figures.—Aedeagus: Pl. VII, fig. 70. Habitus: Pl. I, fig. 10.

Female not known.

Distribution.—Collected in June and July in the Blue Mountains region; one specimen in March in the John Crow Mountains, and one in February near Priestman's River, Portland.

Holotype.—No. 55624, U.S.N.M.

Photinus amplus Barber

Barber, 1941, Proc. Rochester Acad. Sci. 8: 9, 10.

Photinus ebriosus E. Olivier (in part). (May be confused with *P. euphotus* Barber.)

Description prepared from Buck's specimens Nos. 792, 799, and 893.

A medium to large size reddish-brown lampyrid, distinctly elliptical; tergites pale. Size, 12.0 to 14.0 mm. long, 5.0 to 6.0 mm. broad.

Pronotum 2.75–3.4 × 4.25–5.0 mm.; semi-elliptical, feebly emarginate apically; basal edge only slightly sinuate; pale yellow except for narrow ivory border and transverse rectangular infuscation, 1.25–1.8 × 2.25–2.75 mm., in basal half; darkened over eyes and inflated on each side of median line; no distinct sulcus.

Scutellum brown, may be lighter apically; mesonotal plates dull brown.

Elytra 9.3–10.4 × 2.45–3.0 mm.; widest at about midlength, distinctly narrowing toward apices, giving an elliptical outline; reddish brown; explanate margins 0.7–0.8 mm. wide, narrowing somewhat toward base and tapering to a line apically, and may be somewhat paler than the disk; sutural lines light.

Frons brown, concave, 0.5–0.6 mm. wide above antennal sockets; interocular margins very slightly divergent; width across eyes 2.1–2.4 mm.; eye length 1.1–1.25 mm. Clypeus light brown, short, somewhat bilobed. Mandibles rather small for a lampyrid of this size, 0.55–0.7 mm. across in closed

position. Maxillary palpi very large, terminal article 0.55 mm. long on flattened inner face; brown. Labial palpi light brown.

Antennae brown, somewhat compressed; 3.85–4.5 mm. long, relatively short.

Thorax ventrally light brown.

Tergites all pale, white to yellow.

Ventral abdominal segments 2, 3, and 4 light brown; 5 white; 6 and 7 luminous, about 1.25 times as long as 5, and 5 longer than 4; 8 and 9 white.

Legs rather long, posterior pair 4.3–6.0 mm.; tibial spurs small.

Figures.—Aedeagus: Pl. IX, figs. 80 and 81. Habitus: Pl. III, fig. 45.

Female more broadly elliptical; sternites 2 to 4 pale brownish; 8 nearly equilaterally triangular, pale yellowish white, narrowly emarginate.

Distribution.—Collected from Cornpuss Gap in the eastern end to Bush Mountain in the western end, at 200 to 5,000 ft. altitude, from January to September; probably distributed all over the Island, except possibly in the southwestern portion. Common.

Holotype.—In A.M.N.H.; Allotype, No. 55634, U.S.N.M.

Photinus blackwelderi Barber

Barber, 1941, Proc. Rochester Acad. Sci. 8: 5, 6.

Description prepared from two paratypes in the U. S. National Museum and four specimens collected by McDermott in 1952.

A small lampyrid with pale yellowish elytra marked by brown longitudinal vittae; pronotum yellow with a small, median, brown vitta. May be confused with *P. commissus*, and with the smaller *P. chapini*. Size, 8.0 to 8.5 mm. long, 2.7 to 3.0 mm. broad.

Pronotum 1.55–1.8 × 2.5–2.6 mm.; semi-elliptic, broadly rounded, proportionately rather short; mainly opaque yellow with a narrow white border and a narrow median brown streak on the basal half of the disk; not noticeably darkened over eyes; no intumescences.

Scutellum dark brown to black, with yellow lateral borders and apex; mesonotal plates pale to light brown, dull.

Elytra 6.4–6.5 × 1.35–1.5 mm.; parallel; yellow to yellowish brown; on each a brown vitta, widened basally, and extending somewhat obliquely toward the apex, but may become evanescent at about one-half elytral length; narrow explanate margins, not widened basally, and may be slightly lighter than the ground color; two distinct costae on each.

Frons yellow to light brown, 0.35–0.45 mm. wide; width across eyes 1.45–1.6 mm.; eye length 0.75–0.8 mm. Clypeus yellow to pale brown, propor-

tionately somewhat longer than usual, distal edge straight. Mandibles small, about 0.4 mm. across in closed position; palpi brown.

Antennae 3.0–3.3 mm. long; mostly brown, first two articles may be yellow.

Thorax ventrally yellow.

Tergites all white or pale yellowish.

Ventral abdominal segments all white or pale yellowish; 6 and 7 luminous and 1.25–1.5 times as long as 5; 8 very short and overlapped by pygidium apically.

Legs almost white; posterior pair 3.0–3.5 mm. long; tibial spurs small, pattern 0–2–2.

Figures.—Aedeagus: Pl. VII, fig. 68. Habitus: Pl. II, fig. 32.

Female generally similar, 8.0–9.6 × 2.8–3.1 mm.; pronotum 1.8–1.9 × 2.6–2.9 mm.; width across eyes 1.15–1.4 mm.; eye length 0.6–0.7 mm. Tergites 1 to 7 medially brownish, laterally pale, or the first three may be wholly pale; medially carinate; pygidium ogival, pale. Ventral abdominal segments 2 to 5 mostly or wholly pale, but may have diffuse medial infuscation; 6 laterally pale, median luminous organ; 7 pale; 8 triangular, ivory.

Distribution.—Collected between February and October; in the Blue Mountains region in June and July, otherwise at more western stations; from 200 to 3,500 ft. altitude; fairly common.

Type.—No. 55616, U.S.N.M.

Photinus brunescens Barber

Barber, 1941, Proc. Rochester Acad. Sci. 8: 8.

Description based on paratype in U. S. National Museum, Buck's No. 94.

A medium size lampyrid with dark brown elytra and pale or ivory pronotum. Might be confused with *P. hypoleucus*, but proportionately narrower than the latter. Size, 12.0 mm. long, 4.5 mm. broad.

Pronotum 2.5 × 3.35 mm.; semi-elliptical; mostly pale or ivory; irregular warty median infuscation in posterior half and two small spots at basal thirds and lateral thirds; basal edge only slightly sinuate; complete narrow white border; darkened over eyes; angles but little produced.

Scutellum dark brown, apex paler; mesonotal plates ivory.

Elytra 9.75 × 2.2 mm.; parallel; dark brown, narrow lateral and very narrow sutural borders may be lighter; narrow explanate margins.

Frons slightly concave; black; 0.65–0.75 mm. wide; interocular margins slightly divergent. Width across eyes 2.4 mm.; eye length 1.45 mm. Clypeus light brown, very short. Mandibles large, sickle-shaped, 0.85 mm. across in closed position. Maxillary and labial palpi large, brown. Tuft of hairs between antennal sockets.

Antennae 4.25 mm. long, dark brown.

Thorax ventrally white medially.

Tergites 1 to 4 brown, 5 to 8 black.

Ventral abdominal segments 2, 3, and 4 dark brown; 5 white with lateral sixths brown; 6 and 7 luminous, 6 somewhat and 7 definitely longer than 5.

Posterior legs 5.7 mm. long; tibial spurs small, pattern 0–2–2.

Figures.—Aedeagus: Pl. VIII, fig. 73. Habitus: Pl. III, fig. 46.

Female not identified.

Distribution.—Collected only in the Blue Mountains regions in July and August. Rare.

Type.—No. 55626, U.S.N.M.

Photinus ceratus Leng & Mutchler

Leng and Mutchler, 1922, Bull. Amer. Mus. Nat. Hist. 46(VIII): 459.

(See also *Photinus morbosus* Barber. These two species are so much alike that a general description would almost serve for both. An arbitrary separation can be made at 8 mm. over-all length, those specimens less than this length frequently showing a definite pronotal spot, usually roughly circular or sub-cordate, while those measuring more than 8 mm. usually have only a faint, diffuse, infuscation of the pronotum; the smaller specimens also tend to have slightly darker elytra and to be proportionately somewhat narrower. However, in superficial appearance they are no more similar than, for example, *P. alticola* and *P. flavolimbatus*, but the aedeagi do not differ as much as in the latter case.)

Description prepared from specimens collected by Buck in 1936 and 1941 and by McDermott in 1952, and an eutopotype from the Wickham Collection, 1919, the latter being the largest of the specimens and much darkened.

A medium size lampyrid with pale brown elytra and a pale pronotum; no specific markings. Size, 8.0 to 10.0 mm. long, 3.0 to 3.3 mm. broad.

Pronotum 1.8–2.4 × 2.0–2.9 mm.; semi-elliptical; generally pale; basolateral triangular areas white, coarsely punctate; disk yellowish, and may show indefinite faint infuscation, or a central yellow spot; reniform darkening over eyes; irregularly roughened, but not definitely intumescent.

Scutellum brown to light brown, may be pale apically; mesonotal plates dull light brown, paler in occasional specimens.

Elytra 6.0–7.5 × 1.3–1.6 mm.; sub-parallel; color from pale tan to light reddish brown, darker in old specimens but also darker in McDermott's 1952 specimens than in Buck's specimens, and appearing darker over wings; no distinct lateral or sutural borders; narrow explanate margins somewhat widened in basal fourth, and may be slightly lighter or darker than ground color; usually darkened basally.

Frons brown to nearly black, lighter in some specimens; about 0.5 mm. wide, warty, somewhat concave; interocular margins scarcely divergent. width across eyes 1.5–1.85 mm.; eye length 0.7–1.0 mm. Clypeus short, basally brown, apically white, and like the frons, may or may not be hairy; apical edge straight. Mandibles relatively large. Maxillary palpi light brown to brown; labial palpi small, light brown.

Antennae 3.5–4.35 mm. long; brown to nearly black; tapering; articles 2 to 4 sometimes appear thicker than 5 to 11.

Thorax ventrally white to pale brown.

Tergites usually all white or very pale; 1 to 5 may be slightly infuscate.

Ventral abdominal segments white; 2 to 5 short, 6 and 7 luminous and longer than 5.

Legs white, yellow, or light brown; posterior pair 4.0–4.9 mm. long; tibial spurs very small, pattern 0–2–2.

Figures.—Aedeagus: Pl. X, fig. 86. Habitus: Pl. I, fig. 27.

Females similar to male; eyes smaller, antennae shorter, 1.9–2.8 mm. long; posterior legs 3.0–3.3 mm. long.

Distribution.—No record of collections in April, May, or September; in June and July in the Blue Mountains regions at 3,200 to 5,000 feet, and also on the plateau at 1,200–2,100 ft.; other collections at stations from Priestman's River westward to Mandeville, and to sea level. Common and widely distributed.

Holotype.— ♂ , in A.M.N.H.; allotype ♀ , No. 135, A.M.N.H.

Photinus chapini Barber

Barber, 1941, Proc. Rochester Acad. Sci. 8: 6.

Description prepared from specimen collected by E. A. Chapin in February, 1937.

A small lampyrid with pale yellowish elytra bearing brown longitudinal vittae. Resembles a small *P. blackwelderi* and might be confused with the latter or with *P. commissus*. .Size, 6.1 mm. long, 1.7 mm. broad.

Pronotum 1.1 × 1.5 mm.; semi-elliptical; appearance much as in *P. blackwelderi*.

Scutellum basally brown, apically white; mesonotal plates dull light brown.

Elytra 5.0 × 0.85 mm.; parallel; no distinct lateral border; lateral explanate margins narrow; one longitudinal brown vitta on each, about 0.75 of elytral length.

Frons brown, about 0.25 mm. wide; width across eyes 1.05 mm.; eye length 0.55 mm. Clypeus very short, pale. Mandibles very small, 0.2 mm. across in closed position. Maxillary palpi very light brown and white; labial palpi very small, white.

Antennae 2.5 mm. long, brown.

Thorax ventrally light brown.

Tergites all white or pale.

Ventral abdominal segments all white or pale.

Legs pale, slightly infuscate at proximal ends of tibiae.

Figures.—Aedeagus: Pl. XI, fig. 90. Habitus: Pl. I, fig. 6.

Female unknown.

Distribution.—Two collections only, in February and March, on the plateau and relatively western. Rare.

Type.—No. 55617, U.S.N.M.

Photinus commissus E. Olivier

Olivier, 1907, Genera Insectorum (Wytsman), Fasc. 53: 34.

Description prepared from several specimens in the U. S. National Museum and those collected by McDermott in 1952.

A small lampyrid having yellow elytra marked with a distinctive pattern of brown vittae; ventrally white. There is a possibility of confusion with *P. blackwelderi* and *P. chapini.* Size, 6.0–6.5 mm. long, 2.1–2.5 mm. broad.

Pronotum 1.2–1.3 × 2.0–2.5 mm.; semi-elliptical; ground color opaque yellow with very narrow white apical and lateral borders; median rectangular brown spot, divided by longitudinal sulcus; two small lateral spots may also be present; posterior margin slightly sinuate; angles project slightly posteriorly; two baso-lateral intumescences.

Scutellum basally yellow, apically brown; mesonotal plates yellow edged with brown.

Elytra 5.0–5.25 × 1.0–1.25 mm.; parallel; ground color yellow, varying from pale to decidedly brownish; vittae dark brown, consisting of an anterior portion which curves inward so that the ends meet at the suture at about one-half the elytral length, and a posterior portion parallel to the margins and nearly reaching the apices; occasionally the posterior ends of the anterior vittae may be incomplete or even absent, giving the insects a superficial resemblance to *P. blackwelderi;* narrow explanate margins.

Frons about 0.4 mm. wide, brown, polished, and somewhat warty; inter-

ocular margins somewhat divergent; width across eyes 1.3 mm.; eye length 0.6 mm. Clypeus semicircular, yellow, apically white and slightly bilobed. Mandibles small, about 0.3 mm. across in closed position. Maxillary palpi brown and white; labial palpi white.

Antennae about 2.25 mm. long (proportionately rather short); color varies from white to brown, more or less infuscate in most specimens.

Thorax ventrally light brown.

Tergites all pale, nearly white.

Ventral abdominal segments 2 to 5 white, or may be mottled; 6 and 7 luminous and distinctly longer than 5; foveae distinct on 6 and 7.

Legs white; lobes of the fourth tarsal article extend to the pale brown claws; tibial spurs very small, pattern 0–2–2; coxae white.

Figures.—Aedeagus: Pl. XIII, figs. 98–101. Habitus: Pl. I, fig. 11.

Female similar to male; antennae shorter, eyes smaller; luminous organ small and roughly circular; occupying only about median fourth of sternite 6.

Distribution.—Collected in every month except May and September; in the Blue Mountains region in July and August at 3,000–5,000 ft. altitude, but in the same months on the coast and the plateau from sea level to 2,100 ft. Apparently uniformly distributed over the Island, at least below 5,000 ft. Very common.

Type.—Presumably in the Olivier Collection, Muséum National d'Histoire Naturelle, Paris.

Photinus elisabethae Buck

Buck, 1947, Proc. U. S. Nat. Mus. 97 (no. 3210): 68–70.

Description based on that of Buck, 1947.

A small to medium size lampyrid with dark brown elytra having wide, pale, lateral borders. Size, 8.0 to 8.25 mm. long, 2.7–3.0 mm. broad.

Pronotum 1.65–1.8 × 2.1–2.3 mm.; semicircular in apical half; ground color ivory; reniform darkening over eyes; yellowish brown area about 0.85 × 1.35 mm. in basal half with roughly circular brown spot 0.5 mm. in diameter in middle of disk; angles fairly sharp and somewhat produced.

Scutellum brown basally, yellow apically; mesonotal plates dull brown, lighter than base of scutellum.

Elytra 6.5–6.6 × 1.35–1.5 mm.; sub-parallel, widest at basal fourth, due to the widening of the otherwise narrow explanate margins; ground color dark brown, with wide lateral and narrow sutural borders white to pale yellow.

Frons 0.45–0.48 mm. wide, black; interocular margins very slightly divergent. Clypeus semicircular, short, light brownish yellow, apically white.

Mandibles small, about 0.3 mm. across in closed position. Maxillary palpi brown; labial palpi small, white, rather broad.

Antennae brown, 3.4 mm. long.

Thorax ventrally dark brown.

Tergites 1 to 5 brown; 6 to 8 white.

Ventral abdominal segments 2 to 4 brown, becoming lighter in this order; apical half of 5 white; 6 and 7 luminous; 8 white.

Legs rather long, posterior pair 4.0 mm. long, pale; 1st and 2nd pairs light brown; tibial spurs very small, pattern 0–2–2.

Figures.—Aedeagus: Pl. XI, fig. 88. Habitus: Pl. I, fig. 28.

Female similar to male but rather broader, eyes smaller. More numerous than males.

Distribution.—Collected only in June and July, on Mossman's and Catherine's Peaks in the Blue Mountains.

Type.—No. 57316 U.S.N.M.

Photinus euphotus Barber

Barber, 1941, Proc. Rochester Acad. Sci. 8: 9.
Photinus ebriosus E. Olivier (in part).

Description prepared from two specimens collected by Buck in 1941.

A rather large lampyrid with reddish brown elytra narrowly margined paler; long elliptical outline. May be confused with *P. amplus*. Size, 13.0 to 14.5 mm. long, 5.6 to 6.0 mm. broad. (A specimen 12 mm. long is recorded.)

Pronotum 2.5–2.75 × 4.2–4.3 mm.; semi-elliptical; ground color nearly white, with a narrow complete white border, and a roughly rectangular discal brown spot about 1.2 × 2.0 mm., divided by a longitudinal sulcus; darkened over eyes; posterior edge sinuate; angles rounded.

Scutellum light brown; mesonotal plates brown, darker than scutellum.

Elytra about 11.0–11.5 × 2.8–3.0 mm.; sub-parallel, giving a long elliptical outline; tapering to rounded apices in apical third; wide explanate margins, slightly widened in basal fourth to about 0.75 mm.; ground color reddish copper to coppery brown.

Frons nearly flat, warty, dark brown, about 0.75 mm. wide; interocular margins slightly divergent, widening to about 0.85 mm. Width across eyes 2.0–2.5 mm.; eye length about 1.3 mm. Clypeus mainly ivory with two inflated brown areas basally; distal edge nearly straight. Mandibles dark brown in distal half, lighter basally; about 0.6 mm. across in closed position—not especially large for an insect of this size. Maxillary palpi dark brown; labial palpi brown.

Antennae about 3.6 mm. long—rather short for a lampyrid of this size and noticeably short and stubby in some specimens; black with a white ring at each article; sockets large.

Thorax ventrally very pale tan color.

Tergites all light brown, sometimes partly darker; pygidium brownish, apex pale.

Ventral abdominal segments 2 to 5 very short, light brown in lateral thirds, blotched white in median thirds; 5 tends to be darker than 2 to 4; 6 and 7 luminous, unusually wide and long; 8 white; 9 elliptical, white.

Legs with femora pale tan colored, tibiae and tarsi dark brown; lobes of the fourth tarsal article very long, nearly reaching the claws; coxae nearly white; tibial spurs small, pattern apparently 0–2–2.

Figures.—Aedeagus: Pl. XII, fig. 96. Habitus: Pl. III, fig. 50.

Female not definitely known, but an apterous larviform specimen in the collection of the Institute of Jamaica is very probably this species.

Distribution.—Collections from sea level to 5,000 ft., mostly in the eastern third of the Island, but as far west as Mocho, St. James Parish, on the plateau. Not collected in March, May, June, August, or September.

Type.—No. 55632, U.S.N.M.

Photinus euphotus cinchonae

Barber, 1941, Proc. Rochester Acad. Sci. 8: 9.

Barber gives the following differences between the nominate subspecies and this subspecies:

	euphotus euphotus	*euphotus cinchonae*
Interocular width below antennal socket	$\frac{2}{3}$ width of eye	$\frac{3}{3}$+ width of eye
Eyes	.....	Smaller than in *euphotus euphotus*
Length of ventral segments 2 to 5	About equal to sternite 6	About equal to total of sternites 6 and 7
Color of ventral segments 2 to 5	Mostly pale	Strongly infuscate except median fourth pallescent
Foveae in ventral segments 6 and 7	Unusually large and sharply defined	Normal

Specimens collected at high altitudes should be examined for correlations with these differences.

Type.—A.M.N.H.

Photinus evanescens Barber

Barber, 1941, Proc. Rochester Acad. Sci. 8: 10.

Specimens of this and its varieties have been previously determined as *P. maritimus* E. Olivier, *P. contemptus* E. Olivier, and *P. suavis* E. Olivier, so these are synonyms in part.

Description prepared from one paratype in the U. S. National Museum, two specimens collected by Buck in 1936, and fourteen collected by McDermott in 1952, all males.

A small, somewhat elliptical lampyrid with very dark brown to black elytra, a brown pronotal spot, and rather short antennae. Quite variable in size, and larger specimens may be confused with small specimens of *P. lobatus*. Size, 6.5 to 7.9 mm. long, 2.7 to 3.0 mm. broad. (One specimen 11 mm. long was collected at 5,000 ft.)

Pronotum 1.35–1.65 × 2.25–2.75 mm.; outline parabolic to semi-elliptical; mottled white, darkened over eyes; large yellowish area in basal half, which may be irregularly marked with infuscate spots, though usually there is a larger median spot and smaller lateral spots or streaks; basal edge slightly curved, barely sinuate; slightly intumescent.

Scutellum brown; mesonotal plates duller and usually darker than scutellum, but lighter in occasional specimens.

Elytra 5.0–6.5 × 1.35–1.5 mm.; slightly arcuate outwardly, giving a narrowly elliptical outline; narrow explanate margins, slightly widened in basal fourth; nearly uniform very dark brown to black, and may be darkened basally; no definite paler borders but explanate margins may be lighter than ground color.

Frons dark brown, hairy; interocular margins divergent; width across eyes 1.2–1.25 mm.; eye length 0.6–0.7 mm. Clypeus short, light brown, distal edge straight. Mandibles small, 0.35 mm. across in closed position, reddish brown. Maxillary palpi dark brown; labial palpi small, white.

Antennae 2.0–3.0 mm. long, dark brown; usually tapering from fifth article to apex.

Thorax ventrally light brown.

Tergites all more or less brown; the anterior three may be paler; apical edge of 7 sinuate with short median point; 8 may be pale laterally.

Ventral abdominal segments 2, 3, and 4 brown with white apical edges; 5 medially white, laterally brown; 6 and 7 luminous and longer than 5; 8 white; 9 small, white, triangular.

Legs with posterior pair about 3.0 mm. long; femora generally light brown on inner side, yellow on outer side; tibiae and tarsi dark brown; tibial spurs small, brown, pattern 0–2–2.

Figures.—Aedeagus: Pl. IX, fig. 79. Habitus: Pl. I, fig. 9.

Female unidentified. A number of the unconnected females collected may be of this species, but none were taken in copulation.

Distribution.—The only species represented by specimens collected in every month; most collections from sea level to 2,100 ft., but up to 5,000 ft. in the Blue Mountains in July. Probably present over the entire Island.

Type.—No. 55638, U.S.N.M.

This common and widely distributed species is apparently subject to considerable variation. Barber (1941) described three subspecies, but as their ranges considerably overlap and the distinctions between them are relatively slight, we regard them as varieties and list them as such below.

Variety *moneague:* Somewhat smaller, 6.0–6.5 mm. long; posterior tergites somewhat infuscate. Collected in July and August, principally at 1,500–3,500 ft., but also at sea level; from Cornpuss Gap west to Mandeville.

Type.—No. 55640, U.S.N.M.

Variety *montego:* Tergites 6 and 7 infuscate, 8 pale or basally infuscate; 5 black. Collected in July and August, at sea level to 1,200 ft., and from Stony Hill west to Montego Bay.

Type.—No. 55641, U.S.N.M.

Variety *dubius:* Slightly larger than the typical *evanescens;* tergites 6 to 8 pale; antennae about 2.5 mm. long. Collected in January, March, and July, at sea level to 5,000 ft., and from Bath, St. Thomas, west to Montego Bay.[12]

Figure.—Habitus: Pl. I, fig. 25.

Type.—No. 55639, U.S.N.M.

Photinus flavolimbatus Barber

Barber, 1941, Proc. Rochester Acad. Sci. 8: 7.

Description prepared from three specimens collected by Buck in 1941.

A small lampyrid with dark brown elytra having broad yellowish or white borders. May be confused with the slightly smaller *P. alticola.* Size, 6.5 to 7.0 mm. long, 2.6 to 3.0 mm. broad.

[12] In view of the fact that the light emission pattern of the specimens determined as var. *dubius,* collected by McDermott in 1952, differs from that of *evanescens* s. s., *dubius* may be a valid distinct species, but further observations are necessary.

Pronotum about 1.5 × 1.9 mm.; semi-elliptical; translucent yellowish, slightly darkened over eyes; no distinct border; a light brown spot about 0.8 × 1.0 mm. in basal half; angles rather sharp and slightly produced; very narrow median sulcus; some intumescence.

Scutellum and mesonotal plates brown.

Elytra 5.3–5.5 × 1.3–1.5 mm.; parallel; dark brown, paling toward apex; yellowish white lateral border about 0.25 mm. wide, and narrow white line at suture; explanate margins narrow.

Frons dark brown, polished, concave; width across eyes about 1.25 mm.; eye length 0.65 mm. Clypeus short, light brown with white apical edge. Mandibles small, 0.3 mm. across in closed position. Maxillary palpi dark brown; terminal article about 0.5 mm. long—proportionately rather large. Labial palpi small, brown.

Antennae 2.5 mm. long; brown with pale ring at each article; sockets white.

Thorax ventrally brown.

Tergites 1 and 2 white, 3, 4, and 5 brown; 8 white. In one specimen tergites 1 to 5 were pale brown.

Ventral abdominal segments 2, 3, and 4 light brown; 5 medially white and laterally brown, almost transparent; 6 and 7 luminous, about 1.5 times as long as 5; 8 and 9 white; foveae distinct on 2 to 7.

Legs brown; tibiae and tarsi darker than femora; lobes of fourth tarsal article nearly reach the claws; tibial spurs very small, pattern 0–2–2; coxae brown.

Figures.—Aedeagus: Pl. XI, fig. 92. Habitus: Pl. I, fig. 23.

Female brachelytral.

Distribution.—Collected only in June and July and only in the Blue Mountains region at 3,500–6,600 ft. Relatively scarce.

Type.—No. 55623, U.S.N.M.

Photinus gracilobus Barber

Barber, 1941, Proc. Rochester Acad. Sci. 8: 6.

Description prepared from six specimens collected by Buck.

A small pale yellowish grey lampyrid. Somewhat resembles *P. ceratus* and *P. morbosus,* but distinguishable by the aedeagus. Size, 6.85 to 7.95 mm. long, 4.0 to 4.5 mm. broad.

Pronotum 1.5–1.75 × 2.0–2.25 mm.; broadly semi-elliptical; but apical edge somewhat projecting; ground color opaque white, darkened over eyes; angles rounded and slightly produced; usually with a roughly circular brown spot about 0.7 mm. in diameter in basal half and two small spots at lateral fourths, but in some specimens the entire area embracing these spots may be more or less infuscate.

Scutellum basally dark brown, apically paler; mesonotal plates dull ivory.

Elytra 5.35–6.2 × 1.25–1.55 mm.; sub-parallel; greyish yellow-brown or very light tan color; hairy except at humeri, which are bare and brown; explanate margins narrow, hardly widened in basal fourth, and may be paler than ground color.

Frons black, concave; interocular margins very slightly divergent; tuft of hairs between the antennal sockets. Width across eyes 1.35–1.5 mm.; eye length 0.7–1.0 mm. Clypeus short, semicircular, light brown. Mandibles small, 0.35 mm. across in closed position. Maxillary palpi brown; labial palpi very small, white. Antennal sockets relatively large, giving a "monkey-face" effect.[13]

Antennae 2.5–2.6 mm. long; brown, no white visible.

Thorax ventrally light brown.

Tergites all brown; pygidium black; postero-lateral projecting points on 5, 6, and 7.

Ventral abdominal segments 2 to 5 brown to black; apical edges nearly straight; 6 and 7 have narrow brown lateral margins around the luminous area, with a white line inside the brown border; 8 very small, laterally brown, medially white; 9 small, white, narrowly triangular.

Legs with coxae light brown, femora pale brown, tibiae and tarsi dark brown; tibial spurs small, pattern 0–2–2.

Figures.—Aedeagus: Pl. XII, fig. 94. Habitus: Pl. I, fig. 19.

Female brachelytral.

Distribution.—Collected only in March, June, July, and September, mostly in the Blue Mountains region, but one specimen each at Cornpuss Gap, near Kingston, and Claremont.

Type.—No. 55619, U.S.N.M.

Photinus harveyi Buck

Buck, 1947, Proc. U. S. Nat. Mus. 97 (no. 3210): 68.

Description prepared from that of Buck.

A very small lampyrid with medium brown elytra broadly bordered with white; elytral width considerably greater than the orange or yellow pronotum; the smallest known Jamaican *Photinus*. Size, 4.4 to 4.6 mm. long, 1.9 mm. broad.

Pronotum 0.9 × 1.3 mm.; semi-elliptical; basal edge straight or slightly emarginate; disk pale yellow or orange, lighter along apical and lateral margins; angles rather acute and somewhat salient.

Scutellum dark brown; mesonotal plates light brown.

[13] This effect is difficult to describe otherwise; in a direct frontal view the arrangement of the antennal sockets and epistome produce the effect of the face of a capuchin monkey (see description of *P. melanurus*).

Elytra 3.6 × 0.9 mm.; sub-parallel, narrowing in apical third; medium brown with white lateral borders about 0.2 of width; narrow sutural line; vestiture pale, fine, and rather sparse; narrow explanate margins.

Frons black, slightly concave, interocular margins slightly divergent; width across eyes 0.83 mm.; eye length 0.5 mm. Mandibles very small. Maxillary palpi medium brown; labial palpi white.

Antennae 1.4 mm. long; dark brown; articles 6 to 8 each about twice as long as wide.

Thorax ventrally dark brown.

Tergites 1 to 5 light to medium brown, 6 to 8 white; pygidium ogival, 0.21 × 0.24 mm.

Ventral abdominal segments 2 to 4 dark brown, 5 baso-laterally infuscate; 6 and 7 luminous; 8 and 9 white.

Legs dark brown.

Figures.—Aedeagus: Pl. VII, fig. 69. Habitus: Pl. I, fig. 3.

Female not known.

Distribution.—Only two specimens collected, both in July in the Blue Mountains at 5,000 ft. Rare.

Type.—No. 57320, U.S.N.M.

Photinus hypoleucus Barber

Barber, 1941, Proc. Rochester Acad. Sci. 8: 8, 9.

Description prepared from type specimen in the U. S. National Museum and two specimens in the Institute of Jamaica.

A medium size lampyrid with very dark brown to black elytra having no borders or pattern; tergites and sternites pale. Size, 10.5 to 12.5 mm. long, 4.0 to 6.0 mm. broad.

Pronotum 2.0–2.5 × 3.0–4.5 mm.; semi-elliptical; yellow with large transverse brown area in basal half; a median sulcus may or may not be present; inflated and usually darkened over the large eyes.

Scutellum dark brown to black; mesonotal plates white or ivory.

Elytra 8.5–10.0 × 2.0–3.0 mm.; sub-parallel, giving a narrowly elliptical outline; dark brown to black, no pale borders; narrow explanate margins with a submarginal row of punctures as described by Barber; hair short and black; no vittae or other pattern; costae may be present but are not pronounced; wings black or very dark brown.

Frons mainly black, may be pale on occiput; only slightly concave; tuft of hair between the large antennal sockets; interocular margins parallel to slightly divergent. Width across eyes 2.0–2.9 mm.; eye length 0.9–1.1 mm. (rather large). Clypeus very short, hidden under the large antennal sockets and projecting hair tuft. Mandibles rather small, 0.3–0.4 mm. across in closed position. Maxillary palpi dark brown, terminal article rather large, 0.3–0.4 mm. long. Labial palpi small.

Antennae 4.0–4.5 mm. long, rather short for a lampyrid of this body size; brown; sockets large and close together.

Thorax ventrally yellowish or ivory.

Tergites all pale, practically white in fresh specimens; pygidium subtruncate, bisinuate.

Ventral abdominal segments mainly white to very pale yellow; 2 to 4 may be mottled light brown; only a very narrow edge of 8 may be visible.

Legs rather long for a *Photinus;* infuscation dark but not uniform between specimens. Tibial spurs short, brown, pattern 0–2–2.

Figures.—Aedeagus: Pl. IX, fig. 78. Habitus: Pl. II, fig. 44.

Female not known.

Distribution.—Collected in April and in August; two specimens at High Gate at the edge of the plateau, one at Mandeville, and one in the Blue Mountains at Clydesdale, all in the eastern half of the Island. Apparently scarce.

Holotype.—No. 55630, U.S.N.M.

Photinus leucopyge Barber

Barber, 1941, Proc. Rochester Acad. Sci. 8: 6.
P. melanopyge Barber[14]; *P. suavis* E. Olivier (in part).

Description prepared from four paratypes of *leucopyge* and three of *melanopyge* in the U. S. National Museum.

A small lampyrid with pale to light brown elytra, margins usually paler; pygidium white to black. Size, 4.6 to 6.5 mm. long, 1.8 to 2.4 mm. broad.

Pronotum 1.05–1.4 × 1.4–2.4 mm.; semicircular in apical half, widest just forward of angles; basal edge arcuate; transparent mottled white, with reniform darkening over eyes and some infuscation in basal half, varying from a slight, faint, diffuse area to a definite longitudinal spot; two small lateral spots usually present; irregularly intumescent.

Scutellum and mesonotal plates brown; latter may be lighter than scutellum.

Elytra 3.3–5.0 × 0.9–1.2 mm.; sub-parallel; pale tan colored to light brown,

[14] *P. melanopyge* was originally described by Barber as a separate species; however, the aedeagus is essentially identical with that of *P. leucopyge,* and Barber later concluded that they were synonymous. In the examination of a large number of specimens it was noted that those having the pygidium definitely infuscate averaged smaller, had a more pronounced pronotal infuscation, and somewhat darker elytra and tergites than those with pale pygidia. These differences may be of varietal significance, but we are including all under *P. leucopyge.*

darkened basally; explanate margins narrow, lighter than or concolorous with the ground color, and at most only slightly widened basally.

Frons polished dark brown; interocular margins slightly divergent; width across eyes 1.15–1.3 mm.; eye length 0.5–0.6 mm. Clypeus short, basally light brown, apically white; semicircular. Mandibles small. Maxillary palpi small, light brown; labial palpi small, white to light brown, usually appearing pointed.

Antennae 1.6–2.3 mm. long; brown.

Thorax ventrally light to medium brown.

Tergites 1 to 7 brown, sometimes becoming darker in this order; pygidium transparent white, yellow or black; when dark colored, it may be paler laterally.

Ventral abdominal segments 2 to 5 brown; 5 may be medially white; 6 and 7 luminous; 8 and 9 white.

Legs yellow to light brown; posterior pair 1.85–2.75 mm. long.

Figures.—Aedeagus: Pl. XI, fig. 89. Habitus: Pl. I, fig. 5.

Female not known.

Distribution.—Records range from Manchioneal on the east coast to Belmore Castle, thus covering the eastern two-thirds of the Island, and from sea level to 4,500 ft. (in July). No records of collections in March, April, May, September, or October.

Type.—No. 55620, U.S.N.M.

Photinus lewisi Buck

Buck, 1947, Proc. U. S. Nat. Mus. 97 (no. 3210): 64–65.

Description based on Buck's description and paratype in the U. S. National Museum.

A small lampyrid with dark brown to black elytra; pronotum and apex of abdomen nearly white. Size, 6.5 to 8.1 mm. long, 2.4 to 3.0 mm. broad. (One specimen 6.1 mm. long has been found.)

Pronotum 1.3–1.5 × 1.8–2.2 mm.; semi-elliptical; basal edge a smooth wide-radius curve; angles rounded and scarcely produced; ground color mottled white, with reniform darkening over head and eyes, and diffuse triangular brown spot in basal half; narrow white apical and lateral borders; small median sulcus in basal half; no intumescenses.

Scutellum brown; mesonotal plates dull brown, lighter than scutellum.

Elytra 5.1–6.2 × 1.0–1.3 mm.; parallel; dark brown to practically black; explanate margins narrow, not widened basally, and may be slightly lighter than ground color.

Frons very dark brown to black; proportionately rather wide, 0.4 mm.,

wider than the frontal aspect of an eye; slightly concave; interocular margins slightly divergent. Width across eyes 1.1–1.2 mm.; eye length 0.55–0.65 mm. Clypeus short, light brown, bilobed. Mandibles small, 0.25 mm. across in closed position. Maxillary palpi brown; labial palpi light brown, pointed.

Antennae 2.25–3.0 mm. long; practically black.

Thorax ventrally dark brown.

Tergites 1 to 7 pale to light brown; pygidium white.

Ventral abdominal segments 2 to 4 brown, 5 mostly dark brown, posterior margin white; 8 white.

Legs dark brown; posterior pair about 3.2 mm. long; tibial spurs very inconspicuous, pattern apparently 1–2–2 or 1–2–1(?).

Figures.—Aedeagus: Pl. X, fig. 85. Habitus: Pl. I, fig. 16.

Female similar to male.

Distribution.—Collected mainly in July and August in the Blue Mountains region; one collection at St. Ann's Bay, north coast, in December.

Type.—No. 57315 U.S.N.M.

Photinus lobatus Barber

Barber, 1941, Proc. Rochester Acad. Sci. 8: 10.
(Originally described as *Photinus lobatus lobatus.*)
P. maritimus E. Olivier (in part).

Description prepared from two paratypes in the U. S. National Museum, one specimen collected by Buck in 1936, and one from the Wickham Collection, American Museum of Natural History.

A small to medium size lampyrid with dark brown elytra and a pale pronotum with a large brown spot. (See note under *P. evanescens.*) Size, 8.0 to 10.5 mm. long, 3.2 to 3.9 mm. broad.

Pronotum 1.9–2.05 × 2.6–3.0 mm.; nearly semicircular; basal edge slightly sinuate; angles slightly produced; disk smooth; ground color yellow, with reniform darkening over eyes and indefinite longitudinal brown area in basal half; two small lateral spots may also be present, or there may be a diffuse medial infuscation of the basal half.

Scutellum dark brown, sometimes lighter apically; mesonotal plates dull dark brown.

Elytra 7.1–7.5 × 1.6–1.95 mm.; parallel in basal two-thirds, then narrowed to apices; uniform dark brown, sometimes greyish; explanate margins narrow and not appreciably widened basally, and may be lighter, darker, or concolorous with the ground color.

Frons about 0.4–0.5 mm. wide, dark brown, almost black; interocular margins nearly parallel. Width across eyes 1.6–1.75 mm.; eye length 0.8–0.9 mm. Clypeus short, semicircular, brown; apical edge may be lighter. Mandibles small and slender. Maxillary palpi light brown to brown; labial palpi small, white to light brown.

Antennae 3.0–3.5 mm. long; slightly tapering to apex; terminal article somewhat longer than any of 3 to 10; brown; sockets very prominent in one specimen.

Thorax ventrally light brown to brown.

Tergites 1 to 5 light brown to brown; 5 may be pale and 4 lighter than 3; 6, 7, and 8 white.

Ventral abdominal segments 2 and 3 light brown, 4 partly white, and 5 frequently mainly white; 6 and 7 luminous and about 1.5 to 2 times as long as 5; 8 white.

Legs mostly light brown, darkening distally; tibial spurs very small, pattern 0–2–2.

Figures.—Aedeagus: Pl. X, fig. 84. Habitus: Pl. II, fig. 35.

Female similar to male.

Distribution.—No collections reported in May or in September to December inclusive; sea level to 5,000 ft., and from Port Antonio west to Bush Mountain; widely distributed on the plateau. Common.

Type.—No. 55635, U.S.N.M.

Subspecies.—Barber gave the following as subspecies; as in the case of *P. evanescens* the overlapping ranges and relatively minor differences cause us to regard them as varieties and to list them accordingly.

Variety *obscurellus:* Smaller than type, 6.44 × 2.9 mm.; sternite 5 pallid, baso-laterally infuscate, but variable; elytral margins tend to be lighter. (One paratype examined.) Collected in July and August on the plateau.

Type.—No. 55636, U.S.N.M.

Variety *rapidus:* Sternite 5 wholly black; dimensions 7.35 × 2.9 mm. (One paratype examined.) Collected in April, July, and August, on the north coast and on the plateau.

Type.—No. 55637, U.S.N.M.

Photinus lucernula Barber

Barber, 1941, Proc. Rochester Acad. Sci. 8: 4.

P. maritimus E. Olivier (in part).

Description prepared from three paratypes in the U. S. National Museum and five specimens collected by McDermott in 1952.

A small to medium size, somewhat elliptical lampyrid with reddish brown elytra and a pale pronotum with large discal infuscation; luminous areas on ventral segments 6 and 7 reduced to ½ or ⅓ of the ventral surface. Size, 7.0 to 9.0 mm. long, 3.0 to 3.7 mm. broad.

Pronotum 1.6–2.3 × 2.5–3.1 mm.; broadly semi-elliptical; ground color pale brown, with reniform darkening over eyes; median brown spot in basal half, varying from triangular to a large diffuse area; coarsely punctate ivory explanate border about 0.15 mm. wide extending around angles; somewhat intumescent.

Scutellum dark brown, apically paler; mesonotal plates dark brown.

Elytra 5.5–6.75 × 1.6–1.85 mm.; sub-parallel in basal three-fourths, then narrowing to apices, giving a narrowly elliptical outline; explanate margins narrow, at most very slightly widened at basal fourth; reddish brown, no vittae or distinct lighter borders, but a line of coarse white punctures on both lateral and sutural margins.

Frons dark brown, very concave; interocular margins slightly divergent; width across eyes 1.65–1.9 mm.; eye length 1.0–1.1 mm.; eyes rather large. Clypeus short, semicircular; pale brown, apically white. Mandibles small, light brown. Maxillary palpi rather large, terminal article 0.75–0.8 mm. long; labial palpi small, light brown.

Antennae 2.4–2.9 mm. long, rather short for a lampyrid of this size; brown.

Thorax ventrally reddish brown.

Tergites all brownish, apical edges lighter, or 1 to 4 or 6 may be brown, others pale; pygidium subtruncate, sinuate, apical half pale or mottled.

Ventral abdominal segments 2 to 5 light brown; 6 and 7 not much longer than 5, and brown around the restricted luminous areas; 8 rather larger than usual in *Photinus,* white; 9 small, elliptical, white.

Legs with coxae white, femora pale, tibiae and tarsi darker; posterior pair 4.5–4.1 mm. long; tibial spurs very small, scarcely distinguishable from hairs, pattern 0–2–2.

Figures.—Aedeagus: Pl. XII, fig. 97. Habitus: Pl. II, fig. 42.

Female not known.

Distribution.—Collected mostly at sea level to 2,100 ft., but also in the Blue Mountains to 4,300 ft.; collections in January, June, July, and August. Fairly common.

Holotype.—No. 55614, U.S.N.M.

Photinus lundi Barber

Barber, 1941, Proc. Rochester Acad. Sci. 8: 8.
Photinus suavis E. Olivier (in part).

Description prepared from three paratypes in the U. S. National Museum; one of these was seen but not determined by E. Olivier, and doubtfully determined as *P. suavis* by Leng and Mutchler, 1922.

A small, rather slender lampyrid with dark brown elytra and a pale pronotum with an indistinct median infuscation, and usually widest in apical third to accommodate the proportionately very large eyes. Size, 5.6 to 6.7 mm. long, 2.0 to 2.7 mm. broad. (Specimens up to 8.5 mm. long have been collected.)

Pronotum about 1.3 × 1.5 mm.; broadly semicircular in apical half and characteristically (but not always) widest at about apical third; ground color ivory, with a reniform darkening over eyes and an approximately rectangular, indefinite, infuscation in basal half; coarsely punctate except in pigmented area; slightly intumescent.

Scutellum brown; mesonotal plates ivory.

Elytra 4.35–5.25 × 1.05–1.35 mm.; narrow, parallel; medium to dark brown, somewhat darkened basally; narrow explanate margins not widened basally, concolorous.

Frons brown to black; concave, 0.4–0.55 mm. wide; interocular margins slightly divergent; width across eyes 1.5–1.6 mm.; eye length 0.7–0.75 mm. —proportionately very large eyes. Clypeus short, semicircular, brown. Mandibles small, 0.25–0.35 mm. across in closed position. Maxillary and labial palpi small, brown.

Antennae 2.5–3.0 mm. long, brown.

Thorax ventrally brown.

Tergites all brown to black, but anterior ones may be lighter.

Ventral abdominal segments 2 to 5 dark brown; 6 and 7 luminous and about 1.5 times as long as 5, with darker lateral borders around the luminous tissue, and narrowly overlapped by tergites; 8 small and pale.

Legs mostly brown; posterior pair 2.8–3.0 mm. long; tibial spurs not discernible.

Figures.—Aedeagus: Pl. VIII, fig. 76. Habitus: Pl. I, fig. 17.

Female not known.

Distribution.—Collected in March, June, July, and August; two collections at sea level, and the remainder up to 5,000 ft. in the Blue Mountains; the ranges of the coastal and mountain forms apparently do not overlap, the former being the western

third of the Island, and the latter in the eastern third; no collections reported from the plateau. Specimens collected at high altitudes show some differences from those at lower levels; we have not attempted to define these, but they may represent valid subspecies.

The widened apical third of the pronotum is quite characteristic, being, in most species of *Photinus*, widest just forward of the posterior angles. A single specimen of *P. synchronans* has been found with this type of apical broadening.

Type.—No. 55627, U.S.N.M.

Photinus melanurus Barber

Barber, 1941, Proc. Rochester Acad. Sci. 8: 8.

Description prepared from two specimens collected by Buck in 1941.

A medium size lampyrid with dark brown to black elytra; tergites black. Superficially resembles *P. synchronans* but average length is somewhat greater. Size, 8.0 to 11.0 mm. long, 3.1 to 3.5 mm. broad; rarely less than 9 mm. long.

Pronotum 1.95–2.05 × 2.55–2.6 mm.; broadly semi-elliptical; opaque ivory white, with irregular mottled brown area in basal half, and two small lateral spots; darkened over eyes; narrow white apical and lateral margins; slightly intumescent.

Scutellum dark brown; mesonotal plates white.

Elytra 6.25–7.25 × 1.55–1.75 mm.; sub-parallel; explanate margins narrow, slightly widened in basal fourth; dark brown to black, slightly lighter on margins and suture.

Frons brown, polished, concave; interocular margins slightly divergent; width across eyes about 1.8 mm.; eye length 0.8–0.95 mm. Clypeus light brown, edge white, bilobed. Mandibles small, reddish brown, 0.5 mm. across in closed position. Maxillary palpi dark brown; labial palpi small and pale.

Antennae about 3.6 mm. long; articles brown with white rings at the joints; sockets white, giving the "monkey face" appearance (see note under *P. gracilobus*).

Thorax ventrally light brown and white.

Tergites usually all black; the first two or three may be lighter.

Ventral abdominal segments 2, 3, and 4 light brown to black, narrow, with posterior angles white; 5 medially white, laterally pinkish or infuscate; 6 and 7 luminous and much longer than 5; 8 hardly visible, a narrow white edge only; 9 triangular, white. The abdomen may be largely red.

Legs with coxae and femora mostly white, but tibiae and tarsi darker; lobes of fourth tarsal article long; tibial spurs small, pattern 0–2–2.

Figures.—Aedeagus: Pl. VIII, fig. 75. Habitus: Pl. II, fig. 37.

Female similar to male; abdomen wider; luminous organ occupies most of sternite 6 which is longer than 5, and otherwise infuscate (cf. *P. synchronans.*)

Distribution.—Collected in January, February, March, July, and August, mostly at sea level and on the plateau, but two collections in the Blue Mountains at 2,500 and 6,000 ft.; from Manchioneal west to Belmore Castle.

Type.—No. 55628, U.S.N.M.

Photinus morbosus Barber

Barber, 1941, Proc. Rochester Acad. Sci. 8: 6.

(See also *Photinus ceratus* Leng and Mutchler. *P. morbosus* was originally described by Barber as *P. lobatus morbosus;* later he wrote that it should have been *P. evanescens morbosus,* but it appears to be distinct from either of these species and more nearly related to *P. ceratus.*)

Description prepared from paratype in the U. S. National Museum and specimens collected by Buck.

A small lampyrid with pale brown elytra and pale pronotum, usually with a discal yellow spot. Size, 6.0 to 8.0 mm. long, 2.0 to 2.8 mm. broad.

Pronotum 1.5–1.8 × 2.0–2.1 mm.; semi-elliptical; pale yellow to white, darkened over eyes, and frequently with a roughly circular or subcordate yellow median spot; smaller lateral spots sometimes present; slightly intumescent.

Scutellum light brown to brown; mesonotal plates dull old-ivory to light brown.

Elytra 5.0–6.0 × 1.0–1.4 mm.; sub-parallel, outline narrowly elliptical; pale tan to light reddish brown, no definite lateral or sutural borders, but the narrow explanate margins, slightly widened at basal fourth, may be paler than ground color; darkened basally.

Frons usually dark brown, but may be much lighter in some specimens; width across eyes 1.2–1.55 mm.; eye length 0.6–0.85 mm. Clypeus short, light brown with straight, white, apical edge. Mandibles small. Maxillary and labial palpi pale to light brown.

Antennae 2.5–3.2 mm. long; brown to nearly black.

Thorax ventrally brown.

Tergites and ventral abdominal segments all white to pale yellowish; the anterior segments may be slightly infuscate.

Legs pale to light brown; tibial spurs very small.

Figures.—Aedeagus: Pl. X, fig. 87. Habitus: Pl. I, fig. 20.

Female similar to male; eyes smaller.

Distribution.—Collected only in June, July, and August, from sea level to 5,000 ft., and from Port Antonio west to Montego Bay.

Type.—No. 55618, U.S.N.M.

Photinus naevus Barber

Barber, 1941, Proc. Rochester Acad. Sci. 8: 5.

Description prepared from a number of specimens, particularly from two collected by Buck in 1941.

A medium size lampyrid with very pale greyish yellow eytra; May be confused with *P. pallens* and possibly with *P. ceratus*. Size, 8.0 to 12.0 mm. long by 3.5 to 3.7 mm. broad.

Pronotum 1.8–1.9 × 2.6–2.75 mm.; almost semicircular contour, broadly rounded in front; ground color white, typically with four small spots as described by Barber, but these may be indistinct; disk appears inflated; no sulcus.

Scutellum white, rather broader proportionately than in most species, about 0.65 × 0.6 mm.; scutum entirely white; mesonotal plates ivory.

Elytra 6.6–6.85 × 1.75–1.85 mm.; practically parallel; narrow explanate margins definitely widened in basal fourth; ground color very pale yellowish grey, almost white, resembling *P. pallens*, but darkened basally, giving the effect of two short basal streaks; no pale borders.

Frons white and light brown; interocular margins only slightly divergent; width across eyes 1.55–1.8 mm.; eye length 0.8–0.95 mm. Clypeus semicircular, light brown and white. Mandibles small, slender, light brown; 0.4 mm. across in closed position. Maxillary and labial palpi light brown.

Antennae 3.5–3.9 mm. long; dark brown, first two articles may be paler; slightly tapering from article 6 to 11. Sockets relatively large, interior edges only about 0.05 mm. apart; white.

Thorax ventrally white.

Tergites all white.

Ventral abdominal segments 2 to 5 white, their length increasing in this order; apical margins straight; 6 and 7 luminous; 8 very short, white; 9 ogival, white; foveae visible.

Legs with coxae, femora, and tibiae white; tarsi darker; tibial spurs very small, pattern probably 0–2–2.

Figures.—Aedeagus: Pl. VIII, fig. 74. Habitus: Pl. II, fig. 31.

Female not known.

Distribution.—Collected in January, February, June, and August, from sea level to 1,200 ft. and over most of the Island.

Holotype.—No. 55615, U.S.N.M.

Photinus nothoides Buck

Buck, 1947, Proc. U. S. Nat. Mus. 97 (No. 3210): 67.

Description prepared from that of Buck, 1947.

A very small lampyrid with dark brown elytra with white lateral borders, and pronotum with a large brown discal spot with a white border apparently continuous with those of the elytra. Very similar superficially to *P. nothus* Barber. Size, 5.5 mm. long, 1.8 mm. broad.

Pronotum 1.0 × 1.5 mm.; apically semicircular, basally slightly emarginate; angles acute; most of surface occupied by a large transverse brown spot surrounded by a white border which appears continuous with the elytral borders.

Scutellum and mesonotal plates dark brown.

Elytra 4.5 × 0.9 mm.; sub-parallel, widest at basal sixth and tapering to apical fifth, then more sharply to apices; narrow explanate margins; ground color dark brown, darkened basally; wide white lateral borders, but no sutural borders.

Frons 0.37 mm. wide; dark brown at antennal sockets, black above; slightly concave; interocular margins very divergent, about 30°; width across eyes 0.9 mm.; eye length 0.5 mm. Clypeus short, pale brown, bilobed. Mandibles about 0.25 mm. across in closed position; bases stout, tapering to very sharp points.

Maxillary and labial palpi light to medium brown.

Antennae 1.7 mm. long; first two articles medium brown, remainder dark brown; articles 6 to 8 each 1.5 to 2 times as long as wide.

Thorax ventrally dark brown.

Tergites all medium to dark brown.

Ventral abdominal segments 2 to 4 dark brown; 5 white, apex sinuate; 6, 7, and 8 strongly emarginate medially.

Legs with all coxae and femora white; posterior legs entirely white; tibiae and tarsi of anterior and middle legs medium brown; claws white; tibial spurs not visible.

Figures.—Aedeagus: Pl. VII, fig. 71. Habitus: Pl. I, fig. 4.

Female not known.

Distribution.—Collected only in February, July, and August; in the John Crow Mountains in February, and in the summer in the Blue Mountains region at 4,500–5,000 ft., all in the eastern third of the Island.

Type.—No. 57318, U.S.N.M.

Photinus nothus Barber

Barber, 1941, Proc. Rochester Acad. Sci. 8: 7.

Description prepared from two specimens collected by Buck in 1941.

A very small lampyrid with dark brown elytra having white borders; pronotum with a large discal infuscation. Very similar superficially to *P. nothoides;* distinguishable by aedeagal structure. Size, 5.0 to 5.25 mm. long, 2.0 mm. broad.

Pronotum 1.0–1.25 × 1.5–1.6 mm.; semi-elliptical; basal edge slightly sinuate; angles produced posteriorly about 0.25 mm.; ground color white, forming a complete narrow border around a somewhat irregular brown spot occupying about half of the surface; a pair of reddish spots may be present; darkened over eyes.

Scutellum and mesonotal plates brown.

Elytra 4.0 × 1.0 mm.; sub-parallel, somewhat broadened posteriorly; explanate margins relatively wide, and widened in basal fourth; ground color a dark, somewhat greyish brown; white lateral borders to about apical fourth, and short, very narrow sutural borders may be present.

Frons brown, nearly flat, interocular margins slightly divergent; width across eyes 1.1–1.25 mm.; eye length 0.5–0.55 mm. Clypeus semicircular, brown and white. Mandibles small, 0.25 mm. across in closed position. Maxillary palpi brown, terminal article white edged; labial palpi very small, white.

Antennae 1.75–2.2 mm. long; brown; not compressed; eleventh article has an apical tuft of hairs which makes it appear pointed; very little white visible at joints.

Thorax ventrally brown.

Tergites dark brown to black; pygidium apically pallescent.

Ventral abdominal segments 2 to 5 brown; lighter basally; posterior edge of 5 medially white; 6 and 7 luminous, longer than 5; 8 and 9 white; postero-lateral points of hair on 4 to 7.

Legs brown; distal ends of femora pale; first pair darker than second and third; coxae brown; tibial spurs not discernible.

Figures.—Aedeagus: Pl. XI, fig. 91. Habitus: Pl. I, fig. 8.

Female not known.

Distribution.—Collected only in July in the Blue Mountains region at 3,200 to 7,400 ft.

Type.—No. 55622, U.S.N.M.

Photinus pallens Fabricius

Fabricius, 1798, Ent. Systematica, Supplement, p. 124.

Photinus melanodactylus E. Olivier 1888.

Description prepared from a large series in the U. S. National Museum.

A large, very pale greyish yellow lampyrid. May be confused with the smaller *P. naevus*. Size, 12.0 to 19.0 mm. long, 5.5 to 6.0 mm. broad.

Pronotum 3.0–3.25 × 4.5–5.0 mm.; broadly semi-elliptical, basal edge slightly sinuate, with rounded angles produced posteriorly about 0.35 mm.; short, narrow medium sulcus; not intumescent; ground color opaque white, with a diffuse discal infuscation, frequently only scattered spots but when fully developed giving a "spread eagle" pattern.

Scutellum basally light to medium brown, apically white; mesonotal plates white.

Elytra 10.0–11.25 × 2.75–3.0 mm.; sub-parallel, widest between basal and apical fourths; narrow explanate margins; ground color "white"—essentially a very pale greyish yellow; very narrow lateral and sutural borders a denser white.

Frons pale yellow, slightly concave; width across eyes about 2.5 mm.; eye length about 1.35 mm. Clypeus light brown. Mandibles large, about 0.85 mm. across in closed position. Maxillary palpi brown, inner surface of terminal article white; labial palpi relatively small, white.

Antennae 6.0–6.5 mm. long; tapering slightly from article 3 to 11; articles light brown with white bases.

Thorax ventrally white.

Tergites all white.

Ventral abdominal segments all white; 6 and 7 longer than 5; 9 reniform, apically notched; foveae distinct.

Legs mostly white; tibiae slightly brownish on distal half; tarsi frequently very dark; lobes of fourth article very long, nearly reaching claws; tibial spurs distinct, pattern 0–2–2.

Figures.—Aedeagus: Pl. VI, fig. 65. Habitus: Pl. III, fig. 48.

Female similar to male, averaging longer and broader; eyes smaller.

Distribution.—Collected in every month except May, from sea level to 5,000 ft., and from Port Antonio west to Lucea; probably present everywhere in the Island, except possibly in the southwest portion. Very common.

Photinus pardalis Buck

Buck, 1947, Proc. U. S. Nat. Mus. 97 (no. 3210): 66.

Description prepared from one paratype in the U. S. National Museum; one specimen in the Institute of Jamaica is practically identical.

A small lampyrid with light brown, distinctly spotted, elytra, a character unique among known Jamaican lampyrids. Size, 6.5 to 7.0 mm. long, about 2.5 mm. broad.

Pronotum 1.45×2.0 mm.; parabolic outline; angles rounded and very slightly produced; ground color white, with reniform darkening over head and eyes; slightly intumescent.

Scutellum brown; mesonotal plates light brown. (Originally ivory?)

Elytra about 5.4×1.05 mm.; sub-parallel; very narrow explanate margins, not widened basally; ground color light yellowish brown, irregularly spotted with thirty to forty darker maculae each about 0.2 mm. in diameter; darkened basally; no lighter borders.

Frons reddish brown, about 0.4 mm. wide; interocular margins nearly parallel; width across eyes about 1.3 mm.; eye length 0.65 mm. Clypeus moderately long, basally light brown, apically white. Mandibles small, 0.3 mm. across in closed position. Maxillary palpi light brown; labial palpi small, pale, pointed.

Antennae 2.1 mm. long (rather short); brown.

Prosternum white; meso- and metasterna brown.

Tergites 1 to 4 brown, 5 to 8 white.

Ventral abdominal segments 2 to 4 brown, 5 to 8 white.

Legs mostly brown; posterior pair about 3.0 mm. long; tibial spurs very small, pattern apparently 0–2–2.

Figures.—Aedeagus: Pl. X, fig. 83. Habitus: Pl. I, fig. 15.

Female similar to male but larger; one specimen is 8.4 mm. long and 3.5 mm. broad; more broadly elliptical; apical margin of pronotum slightly blunter than in male, and lateral margins parallel in basal half; basal margin straight; antennae 3.0 mm. long; sternite 5 partly white.

Distribution.—Collected in February, March, August, and October, three of the collections being at 600–1,300 ft., north of Kingston; one at Belmore Castle in the western third of the Island. Not common.

Type.—No. 57317, U.S.N.M.

Photinus synchronans Barber

Barber, 1941, Proc. Rochester Acad. Sci. 8: 9.

Description based on three paratypes in the U. S. National Museum and several other specimens, including those collected by McDermott in 1952.

A small to medium size lampyrid with dark brown to black elytra and a pale pronotum. Probably the species usually responsible for the synchronous flashing reported in Jamaica. Size, 7.5 to 10.0 mm. long, 3.0 to 3.6 mm. broad; usually less than 9 mm. long (cf. *P. melanurus*).

Pronotum 1.65–2.15×2.25–2.85 mm.; semi-elliptical; disk smooth; margins coarsely punctate; somewhat intumescent; ground color dull white or ivory, darkened over eyes; narrow white lateral and apical borders continuous around base; discal infuscation usually indefinite, but may be a small median triangle and two small lateral spots.

Scutellum dark brown, apically paler; mesonotal plates ivory.

Elytra 6.0–7.0×1.5–1.8 mm.; sub-parallel; explanate margins narrow and not widened basally; very dark brown to black, no distinct lateral or sutural borders. (See Barber's remarks on lateral punctures.)

Frons brown, slightly concave; interocular margins usually somewhat curved with little or no divergence; width across eyes 1.65–2.05 mm.; eye length 0.85–1.05 mm. Clypeus very short, light brown, semicircular. Mandibles large and thick, sickle-shaped, about 0.45–0.55 mm. across in closed position. Maxillary palpi brown; labial palpi pale yellowish to white.

Antennae 3.2–3.75 mm. long; brown.

Thorax ventrally light brown to white.

Tergites darkening progressively from the light brown first to dark brown seventh; eighth may be brown in median third, but not wholly black as in *P. melanurus*.

Ventral abdominal segments 2 to 5 light brown, 5 may be partly white; 6 and 7 luminous, longer than 5; 8 and 9 white.

Legs have posterior pair 4.1–4.9 mm. long; femora yellow, tibiae and tarsi more or less infuscate; tibial spurs very small, pattern 0–2–2.

Figures.—Aedeagus: Pl. VII, fig. 72. Habitus: Pl. II, fig. 34.

Female generally similar to male, and about as numerous; somewhat larger and abdomen broader, eyes smaller; sternite 6 mostly pale; sternite 7 may bear small white areas suggesting accessory luminous organs; luminous area of sternite 6 smaller than in female of *P. variabilis*.

Distribution.—One of the few species collected in May, but no record of collection in April; up to 3,500 ft. in the Blue Mountains in July, but mostly between sea level and 2,400 ft.; widely distributed throughout the Island, and very abundant in some parts.

Type.—No. 55631, U.S.N.M.

Photinus variabilis Barber

Barber, 1941, Proc. Rochester Acad. Sci. 8: 8.

Description prepared from three specimens collected by Buck in 1941.

A medium size lampyrid with sub-parallel elytra which are a dark, somewhat purplish, brown, and pale posterior tergites distinctly carinate medially. Size, 7.75–11.0 mm. long, 3.4 to 3.7 mm. broad.

Pronotum 1.75–1.85 × 2.4–2.5 mm.; nearly semicircular; basal margin slightly sinuate; angles slightly produced; slight intumescence; ground color white, may be translucent apically; no distinct lighter border; a nearly circular brown spot about 0.75 mm. in diameter in basal half, and two small lateral spots; the intervening area may be diffusely infuscate.

Scutellum brown; mesonotal plates white.

Elytra 6.0–6.75 × 1.7–1.85 mm.; sub-parallel, outline narrowly elliptical, widest at about apical third; very narrow explanate margins not widened basally; dark purplish or chocolate brown under general illumination, but appearing considerably lighter under the microscope.

Frons brown, about 0.5 mm. wide; interocular margins slightly divergent; width across eyes about 1.6 mm.; eye length about 0.8 mm. Clypeus pale brown basally, apically white; distinctly bilobed. Mandibles light brown, paler at tips, about 0.5 mm. across in closed position. Maxillary palpi brown, terminal article with a small apical projection; labial palpi small, brown.

Antennae about 3.0 mm. long, brown; inner margins of sockets about 0.1 mm. apart.

Thorax ventrally nearly white.

Tergites medially brown, laterally white; at least the posterior five have a median carina in the brown portion.

Ventral abdominal segments 2 to 5 light brown with paler margins, or 3, 4, and 5 may be pale, or 5 mostly pale; 6 and 7 distinctly longer than 5; 8 and 9 white; foveae scarcely visible in one specimen, distinct in others.

Legs with coxae white, femora nearly white, tibiae light brown; lobes of fourth tarsal article extend nearly to claws; tibial spurs very small, pattern 0–2–2.

Figures.—Aedeagus: Pl. VIII, fig. 77. Habitus: Pl. II, fig. 36.

Female similar to male.

Distribution.—Collections in February, June, July, August, and September, mostly at 3,200–5,000 ft. in the Blue Mountains region; two collections in the piedmont near Kingston and at Priestman's River, Portland. Fairly common.

Type.—No. 55629, U.S.N.M.

Photinus xanthophotis Gosse

Gosse, 1848, Ann. Mag. Nat. Hist. (2) I: 208.

P. opulentus E. Olivier 1907.

Description prepared from several specimens, including some taken by Buck in 1936.

A very large lampyrid, the largest so far described from Jamaica, with dark, somewhat purplish, brown elytra and a wide, pale pronotum with large brown spot. Size, 18 to 20 mm. long, 6.5 to 7.0 mm. broad.

Pronotum 3.0–4.0 × about 5.5 mm.; broadly semi-elliptical; angles rounded and but slightly produced; somewhat intumescent; ground color white, with a median brown discal area about 2.25 × 3.2 mm. consisting of a main central portion and two narrow lateral bands with intervening white streaks; darkened over eyes; complete, narrow, white border.

Scutellum dark brown; mesonotal plates nearly white to light brown.

Elytra 14–15 × 3.3–3.5 mm.; nearly parallel to apical fourth, then narrowing in external margins; narrow explanate margins slightly widened in basal fourth; nearly uniform dark brown with a purplish cast, explanate margins and sutural lines may be slightly lighter; wings appear nearly black.

Frons brown, about 1.0 mm. wide; interocular margins slightly divergent; width across eyes about 3.4 mm.; eye length about 1.9 mm. Clypeus rather long, brown, apical edge straight. Mandibles brown, somewhat less sharply acute than usual in *Photinus;* about 1.0 mm. across in closed position. Maxillary palpi dark brown, becoming paler toward apices; labial palpi light brown.

Antennae about 7.5 mm. long, dark brown above, lighter beneath; inner edges of sockets about 0.2 mm. apart.

Thorax ventrally light brown and white.

Tergites all brownish; pygidium longer than corresponding sternite.

Ventral abdominal segments 2, 3, and 4 pale brown with lighter margins, but may be nearly entirely white in some specimens; 5 mostly white; 8 white; 9 dark with pale edge.

Legs with coxae nearly white, femora mainly white, distal portion brown in anterior pair; tibiae and tarsi brown; tibial spurs brown, pattern 0–2–2.

Figures.—Aedeagus: Pl. IX, fig. 82. Habitus: Pl. III, fig. 49.

Female similar to male, but elytra short, often exposing several segments of the abdomen; tergite 8 triangular or ogival, luteous, with a pair of fuscous spots sometimes coalescent.

Distribution.—Collected in every month from January to August, from sea level to 6,100 ft. (but those at higher altitudes may be *P. x. catherinae;* see below.); from Bath, St. Thomas, west to Bush Mountain. Common and widely distributed, and one of the few identified species collected on the southwest coast.

Type.—Presumably in the British Museum (Natural History).

Photinus xanthophotis catherinae Barber

Barber, 1941, Proc. Rochester Acad. Sci. 8: 8.

This sub-species has been collected only in the Blue Mountains in June, July, and August. The male is more elongate than in the nominate subspecies, and the aedeagus relatively longer; the females have long elytra, covering the pale abdomen; tergite 8 trapezoidal, sides sinuate, and apex strongly bi-emarginate.

Type.—No. 55625, U.S.N.M.

Diphotus bucki Barber

Barber, 1941, Proc. Rochester Acad. Sci. 8: 12.

Description prepared from two specimens collected by Buck in 1941; other specimens have been examined.

A medium size lampyrid with dark brown elytra having wide white lateral and narrow sutural borders.

Size, 10.0 to 10.5 mm. long, 3.6 to 4.0 mm. broad.

Pronotum about 2.0×3.0 mm.; nearly regularly semicircular; angles rather sharp; intumescenses conspicuous on each side of median sulcus; ground color opaque ivory white, not darkened over eyes; a brown spot about 1.0×1.75 mm. in basal half, divided by a distinct median sulcus, and sometimes surrounded by a pink fringe.

Scutellum rather long, white; mesonotal plates salmon-pink.

Elytra 8.0–8.5×1.8–1.9 mm.; parallel; wide, explanate margins, not widened basally; narrow white sutural and 0.4 mm. wide lateral borders continuous around apices.

Frons brown, concave, interocular margins very slightly divergent; width across eyes about 1.75 mm.; eye length 1.25 mm., eyes rather large. Clypeus light brown, somewhat bilobed. Mandibles large, tapering distally to short conical points; 0.75 mm. across in closed position. Maxillary palpi greyish yellow, terminal article large; labial palpi short, pale, terminal article pointed with a small knob or spur at the base.

Antennae 5.5 mm. long, brown, no white visible; sockets recessed under the ventral edge of frons.

Thorax ventrally light brown and yellow; pink blotches on vertical surfaces of episterna.

Tergites 1 to 5 pinkish brown; 6 and 7 brown, extending posteriorly beyond the corresponding sternites.

Ventral abdominal segments 2 to 6 pinkish, apical margins yellow and nearly straight; 7 largely brown; 8 longer than 7; 9 long-ogival, yellow to dark brown, apically widened and distorted (see Barber, 1941).

Legs with coxae light brown, femora yellow, tibiae light brown, and tarsi darker; lobes of fourth tarsal article long; tibial spurs indistinguishable.

Figures.—Aedeagus: Pl. V, fig. 58. Habitus: Pl. II, fig. 39.

Female similar to male; eyes and luminous area smaller.

Distribution.—Collected in April, July, and August, all collections except one being in the Blue Mountains and surrounding piedmont, up to 7,400 ft. One record from the Cockpit Country is questionable.

Type.—No. 55643, U.S.N.M.

Diphotus caputdelphini n. sp.

Description based on two male specimens collected by Dr. Thomas H. Farr at Dolphin Head, March 22, 1955, both having the same dimensions. Named for the type locality.

A small lampyrid with white-margined black elytra, very convex black pronotal disk with a metallic bluish luster. Size, 7.0 mm. long, 2.3 mm. broad.

Pronotum 1.4 × 1.75 mm.; widest at basal third; disk very convex, black with a metallic bluish luster; densely punctulate; lateral margins explanate, apical margins slightly reflexed; very narrow translucent lateral and apical edges, with submarginal row of coarse punctures; remainder of margins and apical portion of disk rather densely punctulate; basal edge a smooth curve as seen from above, somewhat sinuate in a vertical plane; posterior angles small, acute, at about a 45° angle from the median line.

Scutellum black, rough but shining; mesonotal plates dull black.

Elytra 5.6 × 1.15 mm.; parallel to apical fourth, then narrowing in lateral margins; black, with a metallic blue luster in one specimen; pronounced brilliant white sutural and lateral borders, the latter coinciding with the explanate margins and about 0.2 mm. wide, with submarginal row of black punctures; borders continuous around apices; disk finely and densely tuberculo-rugose; two barely discernible oblique costae; vestiture short, black, particularly visible on the white borders; epipleura white, except for black blotches near bases. Wings hazy iridescent greyish, translucent but appear black where overlapped.

Frons black, projecting slightly in front of eyes; narrow median channel; width above antennal sockets 0.51 mm.; width across eyes 1.07 mm.; eye length 0.46 mm., eyes rather small. Mandibles stout, brown, much overlapped in closed position, giving only 0.3 mm. across. Clypeus short, brown, emarginate, and fringed with brown hairs. Maxillary palpi black, terminal article of the usual conoidal outline; labial palpi very small, black, terminal article triangular.

Antennae dark brown, 4.7 mm. long.

Thorax ventrally mostly black.

Tergites black; pygidium largely translucent, colorless, ogival, incised at apex.

Ventral segments 3 to 6 at least medially brownish; remainder of surface black; 8 with small, lateral, triangular luminous organs; 9 ogival, translucent.

Legs rather long, posterior pair 5.0 mm. with unusually long tarsi, 1.4 mm., of which 0.64 mm. is in the first article; black, but in one specimen with a metallic bluish luster on femora. Claws simple, brown, rather small; coxal cavities white.

Figures.—Aedeagus: Pl. XII, fig. 95. Habitus: Pl. I, fig. 12.

Female not known.

Distribution.—Collected only at Dolphin Head, in the western end of the Island, in March.

Type.—No. 64222 U. S. National Museum. Paratype in the collection of the Institute of Jamaica, Kingston, Jamaica.

Diphotus dahlgreni Buck

Buck, 1947, Proc. U. S. Nat. Mus. 97 (no. 3210): 71–72.

Description prepared from that of Buck, 1947.

A small lampyrid with medium brown elytra with white borders; pronotal disk brown; outline somewhat elliptical; tergites and sternites becoming progressively darker posteriorly. Size, 7.5 mm. long, 3.2 mm. broad.

Pronotum 1.9×2.4 mm.; apically semicircular, basal margin nearly straight; disk medium to dark brown; wide white apical and lateral borders and narrow basal border.

Scutellum and mesonotal plates dark brown.

Elytra 5.6×1.6 mm.; widest at midlength, lateral margins narrowing smoothly in both directions, giving a somewhat elliptical outline; explanate margins wide, about $\frac{1}{3}$ of elytral width; ground color medium somewhat reddish brown, with wide white lateral borders and no sutural borders.

Frons black, deeply concave, 0.5 mm. wide, interocular margins subparallel; width across eyes 1.6 mm.; eye length 1.0 mm. Clypeus short, semicircular, light brown. Mandibles basally white, distally brown, about 0.7 mm. across in the closed position. Maxillary and labial palpi light brown to white.

Antennae 3.2 mm. long; dark brown; articles 6 to 8 a little more than twice as long as wide.

Thorax ventrally light brown.

Tergites darken progressively from the light brown first to the jet-black semicircular pygidium.

Ventral abdominal segments darkening progressively from the light brown second to the black seventh; posterior edges of 2 to 6 straight; 7 with median apical point.

Legs with coxae, femora, and tarsi light brown, tibiae dark brown; about a dozen slender spurs along the distal ends of the tibiae.

Figures.—Aedeagus: Pl. IV, fig. 55. Habitus: Pl. I, fig. 13.

Female not known.

Distribution.—One specimen collected in January at Belmore Castle in the western third of the Island. Unique.

Type.—No. 57321, U.S.N.M.

Diphotus darlingtoni Buck

Buck, 1947, Proc. U. S. Nat. Mus. 97 (no. 3210): 72–73.

Description prepared from that of Buck, 1947, and notes by H. S. Barber, after examination of the holotype in the Museum of Comparative Zoology.

A small lampyrid with medium brown elytra and dark brown pronotal disk, both with white borders and notably long pubescence; markedly constricted between pronotum and elytra. Superficially somewhat resembles *D. montanus,* but smaller and paler, and elytral vittae more distinct. Size, 7.5 mm. long, 2.8 mm. broad.

Pronotum 1.8–2.3 mm.; widest at midlength and 2.0 mm. wide at base; very convex; basal edge moderately and evenly emarginate; angles about 90°; broadly bordered with white except at basal margin; irregular dark brown median spot on disk, divided by a shallow, paler, median sulcus; strongly punctate; vestiture long and pale.

Scutellum and mesonotal plates brown, lighter than base of elytra.

Elytra 5.8×1.5 mm.; together much broader than the pronotum and widest at basal fourth; ground color pale to light brown, with a medium brown vitta wide at humerus, narrowing posteriorly, and nearly reaching apex; pale, wide lateral borders, widest at basal third and narrowing gradually and evenly in the narrow explanate margins only; sutural borders narrow and pale, basally obsolete; vestiture rather sparse, long and pale.

Frons mottled black and purple, 0.5 mm. wide, markedly concave; interocular margins sub-parallel; width across eye 1.7 mm.; eye length 0.9 mm.; eyes proportionately rather large. Clypeus short, semicircular, pale yellow; recessed under projecting antennal sockets. Mandibles tapering, sharp, distal half brown. Maxillary palpi medium brown, hairy; terminal article of usual conoidal outline; labial palpi small, pale, somewhat obtusely securiform.

Thorax ventrally light brown.

Tergites darken progressively from the light brown first to the dark brown pygidium; latter ogival, broadest just beyond the base; apical border infuscate.

Ventral abdominal segments darken progressively from the light brown second to the dark brown seventh; lighter than tergites; 8 medially, and 9 wholly light brown; posterior margins straight.

Legs light brown; tibial spurs as in *D. dahlgreni,* but very difficult to see.

Figures.—Aedeagus: Pl. V, fig. 57. Habitus: Pl. I, fig. 18.

Female not identified; probably apterous and larviform.

Distribution.—Two specimens collected in January at Cornpuss Gap and at Port Antonio, in the eastern part of the Island and below 2,000 ft.

Type.—No. 26747, M.C.Z.

Diphotus farri n. sp.

Description based on three very similar specimens collected by Dr. Thomas H. Farr, at Dolphin Head, March 22, 1955. Named for the collector.

A small lampyrid with yellowish elytra bearing relatively wide brown vittae. Superficially it resembles the small yellowish species of *Photinus,* such as *P. blackwelderi.* Size, 5.6 mm. long, 2.0 mm. broad.

Pronotum 1.15×1.53 mm.; broadly rounded apically and somewhat inflated over the large eyes; brownish yellow with four rather irregular brown vittae on the disk, the lateral ones shorter; lateral margins parallel or slightly converegnt in basal half; angles about 90°; lateral and apical borders translucent yellowish, coarsely punctate.

Scutellar pigmentation variable; in one specimen the basal third was white, and remainder translucent pale brownish, while in the others the white area was absent, the entire surface being pale brownish, and more translucent in one than in the other; mesonotal plates ivory white.

Elytra 4.46×1.02 mm.; parallel to apical fourth, then narrowing inwardly to apices; explanate margins narrow, with confused punctures; ground color a light, somewhat brownish yellow, with a longitudinal brown vitta about 0.3 mm. wide from base to approximately apical fourth, but apically curving toward the suture parallel to the elytral margins; also two short light brown areas adjacent to the scutellum.

Frons brown, medially concave; width above the antennal sockets about 0.3 mm.; width across eyes 1.15 mm.; eye length 0.8 mm.; eyes distinctly very large, anterior edges visible from above. Clypeus short, light yellowish brown; margins nearly semicircular. Mandibles stout, brown, about 0.33 mm. across in closed position. Maxillary and labial palpi light yellowish brown; of the usual form but the latter very small.

Thorax ventrally light brownish yellow.

Tergites pinkish, except seventh and pygidium which are black.

Ventral abdominal segments 2 to 5 mottled pinkish; 6 brown; 7 black and shorter than 6; 8 apparently entirely luminous by coalescence of the inner edges of the luminous organs; 9 ogival, translucent.

Legs have posterior pair 2.95 mm. long; femora nearly transparent; all brownish yellow.

Figures.—Aedeagus: Pl. XII, fig. 93. Habitus: Pl. I, fig. 7.

Female not collected.

Distribution.—So far not collected elsewhere than at the type locality, Dolphin Head.

Type.—No. 64223 U. S. National Museum, and one paratype. One paratype in the Museum of the Institute of Jamaica, Kingston, Jamaica.

Diphotus flavomarginatus Barber

Barber, 1941, Proc. Rochester Acad. Sci. 8: 12.

Description prepared from the type in the U. S. National Museum.

A small lampyrid with nearly black elytra broadly bordered

with pale yellow; pronotum with a large semi-elliptical brown to black spot divided by a shallow median sulcus. (Barber's 1941 description gives the impression of a darker insect than it actually is. It might be confused with *D. caputdelphini* n. sp. *supra*, but the latter is distinctly black with sharply contrasting white elytral borders.) Size, 7.6 mm. long, 2.5 mm. broad.

Pronotum 1.3 × 2.25 mm.; semi-elliptical; wide pale yellow apical and lateral borders, about 0.5 mm. wide; a large transverse dark brown to black spot in basal half, divided by a shallow median sulcus.

Scutellum light brown with white apex; mesonotal plates brown.

Elytra 6.3 × 1.25 mm.; parallel; ground color dark brown to black, with wide pale lateral and narrower sutural borders; explanate margins about ½ of elytral width at basal fourth, narrowing toward apices; latter slightly dehiscent.

Frons dark brown; interocular margins nearly parallel; width across eyes 1.15 mm.; eye length 0.6 mm. Clypeus short, light brown, indistinctly bilobed. Mandibles rather stout, brown, about 0.5 mm. across in closed position. Maxillary palpi light brown; terminal article conoidal in outline, and proportionately rather large; labial palpi light brown, terminal securiform.

Antennae 4.25 mm. long; first two articles pale, others dark brown.

Thorax ventrally dark brown.

Tergites all brown.

Ventral abdominal segments 2 to 7 dark brown.

Legs pale to light brown, infuscate on inner surfaces of femora and tibiae, with some distal darkening.

Figures.—Aedeagus: Pl. VI, fig. 67. Habitus: Pl. I, fig. 21.

Female similar to male; superficially similar to *D. lucivolans*, but narrower.

Distribution.—Collected on the Blue Mountain peaks at 7,400 ft. in July, and in the John Crow Mountains in March, both in the eastern part of the Island. Rare.

Type (♂).—No. 55644, U.S.N.M.

Diphotus glaucus (G. A. Olivier)

Olivier, 1790, Entomologie, Vol. 2: 13, Pl. 1.
Barber, 1941, Proc. Rochester Acad. Sci. 8: 3.

Occurrence in Jamaica doubtful.

Description prepared from two specimens collected by Dr. G. S. Miller in the Dominican Republic in 1928.

A medium size lampyrid with very pale greyish yellow elytra and an ivory pronotum without infuscation. Could be confused with *Photinus pallens, P. naevus,* or possibly *P. ceratus.*

Size, 11.0 to 11.5 mm. long, 4.0 to 5.0 mm. broad.

Pronotum 2.5–2.6 × 3.2–3.4 mm.; parabolic outline; slightly intumescent on each side of median sulcus; margins ivory and coarsely punctate; disk a very pale, slightly pinkish, yellow, not coarsely punctate; not darkened over eyes.

Scutellum white; mesonotal plates brown.

Elytra 8.6–8.75 × 2.1–2.5 mm.; sub-parallel; very pale greyish yellow; wide explanate margins not widened basally.

Frons brown, 0.6 mm. wide, somewhat concave medially; interocular margins very slightly divergent. Width across eyes 2.1 – 2.2 mm.; eye length 1.1 mm. Clypeus short, yellow to light brown, somewhat bilobed. Mandibles large, 0.7 mm. across in closed position. Maxillary palpi large, light brown; labial palpi small, pale, with two small denticles on distal edge.

Antennae 5.0 mm. long, brown.

Thorax ventrally pale.

Tergites 1 to 4 yellowish; 5 to 8 black. Tergite 8 much overlaps sternite 8 laterally and apically.

Ventral abdominal segments 2 to 5 yellow; 6 and 7 dark brown to black; 9 brown or black, reniform.

Legs all pale; posterior pair 5.0–5.5 mm. long; no tibial spurs discernible.

Figures.—Aedeagus: Pl. V, fig. 62. Habitus: Pl. II, fig. 41.

Female similar to male; ventral segments 6 and 8 black apically, and 7 wholly black.

Distribution.—No definite record of its having been collected in Jamaica.

Type.—Presumably in the Olivier collection, Muséum National d'Histoire Naturelle, Paris. (Cf. description by Leng and Mutchler, 1922).

Diphotus lucivolans Barber

Barber, 1941, Proc. Rochester Acad. Sci. 8: 12.

Description prepared from type female in the U. S. National Museum.

A small lampyrid having dark brown elytra with wide lateral white borders and a pale pronotum marked by a large brown spot. Size, 7.7 mm. long, 3.0 mm. broad.

Pronotum 1.4×2.35 mm.; semi-elliptical, but rather wide for the length, as is characteristic of females; pale, with a large transverse elliptical brown spot partially divided by a median sulcus, giving a somewhat "peanut" shaped outline.

Scutellum white; mesonotal plates brown.

Elytra 6.3×1.5 mm.; sub-parallel; explanate margins about ⅓ of elytral width; apices slightly dehiscent; ground color dark brown, with wide white lateral and narrow sutural borders.

Frons dark brown, somewhat concave; interocular margins divergent; width across eyes 1.15 mm.; eye length 0.5 mm. Clypeus short, light brown, bilobed. Mandibles brown, about 0.5 mm. across in closed position. Maxillary palpi pale, terminal article of usual conoidal outline; labial palpi light brown, securiform with rather pronounced projecting angles.

Antennae very dark brown, except first two articles which are pale yellow.

Thorax ventrally brown.

Tergites light to dark brown; pygidium pale in apical ⅔.

Ventral abdominal segments 2 to 7 darkening in this order from light to medium brown.

Legs all pale; no distinguishable tibial spurs.

Figure.—Habitus: Pl. I, fig. 24.

Male not known; the unique female specimen is somewhat similar to that of *D. flavomarginatus*.

Distribution.—The single specimen was collected in July, on Catherine's Peak, at 5,000 ft.

Holotype.—♀, No. 55645, U.S.N.M.

Diphotus masti Buck

Buck, 1947, Proc. U. S. Nat. Mus. 97 (no. 3210): 73–74.

Description prepared from that of Buck, 1947, and type in U. S. National Museum.

A small lampyrid with parallel light brown elytra with white borders; disk of pronotum dark; tergites and sternites darkened progressively toward apex. Size, about 8.0 mm. long, 3.0 mm. broad.

Pronotum 1.8×2.3 mm.; apical half semicircular, lateral edges parallel or slightly convergent in basal third; basal edge nearly straight, angles slightly produced; wide white apical and lateral borders and narrow basal border; dark brown semicircular discal spot bisected by a narrow median light brown stripe.

Scutellum light brown; mesonotal plates medium brown.

Elytra 6.2×1.5 mm.; nearly parallel to apical fourth, then narrowing sharply; narrow explanate margins, tapering basally rather rapidly to elytral edge and more gently apically; ground color light to medium brown, darkened basally; wide white lateral and narrow sutural borders, confluent around apices.

Frons medium to dark brown, deeply concave, about 0.5 mm. wide; interocular margins parallel or slightly divergent; width across eyes 1.9 mm.; eye length 1.2 mm.; eyes large and visible beyond apical edge of pronotum. (Clypeus not noted.) Mandibles brown, about 0.5 mm. across in closed position. Maxillary and labial palpi white.

Antennae 4.0 mm. long; basal articles light brown, remainder dark brown; 6 to 8 each four times as long as wide, and somewhat compressed; basal articles strongly indented at point of insertion in sockets; sockets prominent between eyes, not symmetrically circular.

Thorax ventrally light brown.

Tergites darkening progressively from the medium brown first to the dark brown, black-bordered pygidium; latter very large, ogival to blunt with small rounded posterior point; 7 and 8 broader than corresponding sternites.

Ventral abdominal segments darkening progressively from the medium brown second to the black seventh; 8 and 9 pale with brown apical edges; 9 elongated and bearing recurved hooks.

Legs light brown; anterior claws of forward tarsi have a "thumb" at the base; circlet of inconspicuous spurs on distal rim of tibiae.

Figures.—Aedeagus: Pl. IV, fig. 52 (identical with that of *D. bucki*). Habitus: Pl. I, fig. 22.

Female not identified.

Distribution.—Collected in March, April, July, and September, all collections being east of Kingston and at 300 to 5,000 ft. Rare.

Type.—No. 57322, U.S.N.M.

Diphotus montanus Barber

Barber, 1941, Proc. Rochester Acad. Sci. 8: 12, 13.
Probably *Photinus pantoni* E. Olivier (in part).

Description prepared from specimens in the U. S. National Museum.

A small to medium size lampyrid with light to medium, somewhat greyish, brown elytra; nearly semicircular opaque white pronotum with two brown spots separated by a pale line, this line making, with the scutellum and the sutural elytral borders, a

continuous median longitudinal line. May be confused with *D. pantoni* or *D. darlingtoni* (see notes under these species). Size, 7.0 to 12.0 mm. long, 2.8 to 3.5 mm. broad. Because of the wide range in size and the relatively large number of small specimens collected, it would seem possible to separate the smaller ones as var. *minor*. These smaller specimens frequently have more red color on the abdominal segments than indicated by this description, but intermediate forms in both size and color are found.

Pronotum 1.2 to 1.4 times as wide as long; semi-elliptical; ground color opaque white or ivory; two irregular somewhat trapezoidal brown spots in basal half, separated by a rather wide pale longitudinal vitta in which may be a shallow sulcus. This vitta, the scutellum, and the elytral sutural line form a continuous pale longitudinal line.

Scutellum white or pale; mesonotal plates dull white or ivory, with narrow brown edges.

Elytra about 5.6-9.0 mm. long (8.00 mm. in a specimen having a total length of 10.5 mm.) × 1.4–1.75 mm. broad; sub-parallel to apical third, giving a long-elliptical outline; ground color a light to medium, somewhat greyish, brown; pale wide lateral and narrow sutural borders, the former narrowing basally and apically with the explanate margins.

Frons brown, polished, medially concave; interocular margins slightly divergent; width across eyes 1.3–1.9 mm.; eye length 0.65–1.05 mm. Clypeus semicircular or feebly bilobed; mainly or entirely brown. Mandibles brown; 0.45–0.9 mm. across in closed position. Maxillary palpi brown, labial palpi pale to light brown; both of usual outline.

Antennae about 2.8–4.75 mm. long (3.75–4.5 mm. in specimens having a total length of 10.0 mm.); brown to black with pale rings at joints; articles 3 to 8 of about the same length, 9 to 11 slightly shorter and distinctly more slender; sockets somewhat recessed under projecting ridge of frons, and with a tuft of hair between them.

Thorax ventrally light to medium brown.

Tergites 1 to 5 yellow to light brown, blotched pink; 6 brown, 7 dark brown; pygidium basally black, apically white.

Ventral abdominal segments 2 to 6 light brown medially, darker laterally, and with some pink coloration; 7 narrow and black; 8 pale, with two nearly circular luminous organs; 9 small, white, ogival. Foveae rather pronounced on some segments.

Legs with coxae pale, femora and tibiae light brown, the latter darkening distally; tarsi light brown, lobes of the fourth article relatively short; no distinguishable tibial spurs.

Figures.—Aedeagus: Pl. V, fig. 61. Habitus: Pl. II, fig. 33.

Female similar to male, but tends to be larger and darker; pygidium black.

Distribution.—Collected in January, February, June, July, and August, the majority of the collections being from Cornpuss Gap and Port Antonio to 5,000 ft. altitude in the Blue Mountains; one record from Catadupa in the western third of the Island. Very common. Apparently at least partly diurnal, having been collected in the daytime on *Polygonum chinense.*

Type.—No. 55646, U.S.N.M.

Diphotus ornicollis Barber

Barber, 1941 Proc. Rochester Acad. Sci. 8: 13.

Description prepared from three specimens collected by Buck.

A medium size lampyrid with pale brown elytra having wide lighter borders; light colored ventrally; lateral edges of tergites 6 and 7 extending over and posteriorly to the corresponding sternites; pronotum white with no distinct infuscation. Has been determined as *Photinus ebriosus* E. Olivier, but can hardly be considered a synonym. Size, 10.0 to 11.0 mm. long, 4.2 to 4.8 mm. broad.

Pronotum 2.25–2.8 × 3.75–4.0 mm.; broadly semi-elliptical; ground color white to pale yellow, denser over head; there may be two small spots laterally to the short and shallow median sulcus.

Scutellum white; mesonotal plates yellow.

Elytra 7.75–8.25 × 2.1–2.4 mm.; sub-parallel, giving a narrowly elliptical outline; wide explanate margins, slightly widened in basal fourth; ground color yellow to tan-color under the microscope but appearing considerably darker under general illumination; broad yellowish lateral border about 0.4 of the elytral width.

Frons light brown, 0.5 mm. wide; interocular margins slightly divergent; width across eyes 2.1–2.35 mm.; eye length 1.2–1.25 mm. Clypeus pale brown basally, with bilobed thickening; apically white. Mandibles noticeably larger and thicker than usual; apically dark brown, basally lighter; 0.85 mm. across in closed position. Maxillary and labial palpi brown.

Antennae about 4.6 mm. long; brown, may be lighter ventrally; joint sockets white; base sockets not separated by projecting ridge of frons.

Thorax ventrally yellow.

Tergites 1 to 5 light brown, 6, 7, and 8 dark brown, 8 may be black; 6 and 7 considerably overlap laterally and extend posterolaterally beyond the corresponding sternites; pygidium much longer than the sternite.

Ventral abdominal segments 2 to 5 yellow to light brown, with pinkish mottling; 5 may be darker on apical margin; apical edges of 2, 3, and 4 sinuate, of 5 to 8 nearly straight. The coloration varies considerably in

different specimens; 6 may be pinkish and yellow-brown, and 7 mostly white or 6 may be mostly dark brown and 7 very dark brown, nearly black; 9 ogival, yellow, apically brown.

Legs mostly yellow, sometimes with slight infuscation; lobes of fourth tarsal article long; claws light brown and appear to have a denticle near the base, especially on the posterior legs; tibial spurs indistinguishable.

Figures.—Aedeagus: Pl. IV, fig. 56. Habitus: Pl. II, fig. 43.

Female not known.

Distribution.—Collected in February, July, August, and December, all collections being on the plateau and from Mandeville westward; relatively common. Remarkable for *Diphotus* in apparently being restricted to lower altitudes.

Type.—No. 55647, U.S.N.M.

Diphotus pantoni (E. Olivier)

E. Olivier, Wytsman Genera Insectorum, 1907, p. 36.
Diphotus mutchleri Barber 1941. Proc. Roch. Acad. Sci. 8: 13.

Description prepared from a paratype of E. Olivier's *Photinus pantoni* kindly loaned by the Muséum National d'Histoire Naturelle, Paris (Dr. A. Descarpentries), and Barber's type of *D. mutchleri* in the U. S. National Museum.

Olivier's description of *Photinus pantoni* reads "Oblong, dark brown, head black; prothorax sub-ogival, light yellow, two brown spots on disk; scutellum white; elytra brown, suture narrowly and edges widely margined with white; punctate and costulate; legs light. Male abdomen brown, sixth segment black, last waxy, abruply truncate. Female yellowish ventrally, last segment lucid, triangular; antepenultimate segment black. 7–9 mm. long." This differs somewhat from Barber (1941). Olivier's description is inadequate to distinguish his *Photinus pantoni* from Barber's *Diphotus montanus*, and small specimens of the latter had been tentatively identified as *pantoni*. However, the paratype from the Paris Museum is distinctly equivalent to Barber's *D. mutchleri*, and it is necessary, therefore, to regard them as synonyms, making *D. montanus* a probable synonym in part of *Photinus pantoni*.

A small light to medium brown lampyrid, slightly elliptical; pronotum pale, with two short, rather broad, brown vittae,

separated by a pale longitudinal streak covering a short, wide, sulcus in the basal half; an indefinite short and rather broad brown baso-lateral vitta on each elytron. Size, 7.0 to 9.0 mm. long, 2.5 to 3.3 mm. broad.

Pronotum 1.5–2.0 × 2.0–2.6 mm.; semi-elliptical, widest somewhat anterior to the base; basal margins slightly sinuate, angles fairly sharp but only slightly produced; extreme lateral and apical edges slightly reflexed; wide, shallow median sulcus in basal half in a pale streak on each side of which is a brown area about 1 mm. long, the apical margins of which are roughly concentric with the apical edge of the pronotum; remainder of pronotum pale or yellowish, sometimes mottled, forming a border about 0.5 mm. wide laterally and apically around the brown area and laterally explanate; a fine, pale, appressed pubescence over eyes.

Scutellum white or pale; apically truncated; mesonotal plates light brown, may be medially pale.

Elytra 5.5–7.5 × 1.2–1.66 m.; sub-parallel, widest in middle half, the lateral explanate margins about 0.25 of width at middle, narrowing basally and apically; apices dehiscent; ground color a somewhat reddish brown (pale translucent tan color by transmitted light), becoming paler distally; a short, indefinite, brown sub-lateral vitta on each, widened basally; fine, pale, appressed pubescence.

Frons brown, concave, slightly hairy, and may have a darker horseshoe-shaped pattern, opening downward, in the concave portion; interocular margins slightly to quite divergent; width across eyes 1.8–2.1 mm.; eye length 0.75–1.1 mm.; eyes elliptical with long axis horizontal. Clypeus light brown, short, slightly bilobed, hairy. Mandibles brown, about 0.6 mm. across in closed position. Maxillary palpi pale to light brown, terminal article of the usual conoidal outline but rather slender; labial palpi pale.

Antennae 3.0–3.5 mm. long; articles 1 and 2 pale, 3 to 11 brown; 7 to 11 narrower than 1 to 6.

Thorax ventrally light brown, possibly pale in fresh specimens.

Tergites 1 to 3 or 4 light brown, others to sixth brown; 7 black with narrow pale apical margin and projecting postero-lateral points; pygidium black, at least in basal half, apically translucent; 4 to 6 slightly longer than 2 and 3.

Ventral abdominal segments 2 to 4, 5, or 6, medium brown, darkening in this order; 7 black; 8 pale, with two nearly circular luminous organs; 9 small, pale, elliptical or ogival, hairy.

Legs mostly white or pale, with slight distal darkening of tibiae; posterior pair about 4 mm. long; tibiae rather unusually long, 1.9 mm. in one specimen; no discernible tibial spurs.

Figures.—Aedeagus: Pl. IV, fig. 51 (cf. *D. montanus*, Pl. V, fig. 61). Habitus: Pl. I, fig. 29.

Female generally similar to male.

Distribution.—Collected in January, February, March, June, August, September, and October, mostly in the Blue Mountains region at 2,000–5,000 ft.; also in the John Crow Mountains at below 2,000 ft.; three collections on the plateau, one as far west as Catadupa. Common.

Type (*P. pantoni*).—Presumably in the Muséum National d'Histoire Naturelle, Paris.

Type (*D. mutchleri*).—No. 55648, U.S.N.M.

Diphotus semifuscus Barber

Barber, 1941, Proc. Rochester Acad. Sci. 8: 13.

Description prepared from two specimens collected by Buck in 1941.

A medium size lampyrid with brown elytra with wide white borders and a trapezoidal yellow spot on the pronotum. Size, 10.0 to 12.0 mm. long, 4.5 to 4.7 mm. broad.

Pronotum 2.25 × 2.9 mm.; semi-elliptical; nearly transparent mottled white, with a large transverse yellow discal area, divided into two trapezoidal portions, on each side of shallow median sulcus.

Scutellum light brown, narrow; mesonotal plates slightly darker than scutellum.

Elytra 8.0–8.5 × about 2.3 mm.; ground color yellow to brown, with wide white lateral borders, and white sutural lines forming a longitudinal median vitta about 1 mm. wide; explanate margins very wide, and widest at median half, giving a slightly elliptical outline.

Frons brown, hairy; projects over the somewhat recessed antennal sockets but ventrad point does not project between them. Width across eyes 2.0 mm.; eye length 1.0 mm. Clypeus light yellowish brown, apically white; trapezoidal, somewhat bilobed; not inflated. Mandibles dark brown; moderately large, 0.5 mm. across in closed position. Maxillary palpi light brown, terminal article large; labial palpi very pale brown.

Antennae 5.0 mm. long; brown, the first article paler; joint sockets white; articles 3 to 6 of about the same length and thickness, 7 to 11 progressively more slender.

Thorax ventrally brown.

Tergites darkening from 1 which is very light brown to 7 and 8 which are black; 8 may have a pale median streak.

Ventral abdominal segments 2 to 7 brown; foveae distinct; 9 small, white, triangular.

Legs with coxae pale brown, femora light brown, tibiae and tarsi darker; lobes of fourth tarsal article long; tibial spurs, if present, indistinguishable from hairs.

Figures.—Aedeagus: Pl. IV, fig. 53. Habitus: Pl. II, fig. 40.

Female brachypterous, with broad abdomen.

Distribution.—Collected in June and July in the Blue Mountains region at 3,880 to 6,600 ft. Common.

Type.—No. 55649, U.S.N.M.

Diphotus unicus (Mutchler)

Mutchler, 1923, American Museum Novitates No. 63: 4–5.

Description prepared from three specimens collected by Buck in 1936.

A small lampyrid with brown elytra with pale margins; pale yellow or orange pronotum, and white scutellum and mesonotal plates. Size, 5.0 to 7.0 mm. long, 1.9 to 2.3 mm. broad. One specimen 7.95 mm. long recorded.

Pronotum 1.1–1.3 × 1.55–1.85 mm.; semi-elliptical; large trapezoidal yellow or orange area on each side of median sulcus in basal ⅔, borders ivory; reniform darkening over head; coarsely punctate except in pigmented area.

Scutellum white; mesonotal plates ivory.

Elytra 4.4–5.0 × 0.95–1.15 mm.; parallel to apical fourth; narrow explanate margins, slightly widened in basal fourth; ground color dark brown to nearly black; distinct light lateral and sutural borders continuous around apices.

Frons 0.35–0.5 mm. wide, medially concave; medium to dark brown; interocular margins distinctly divergent in two specimens, arcuate around the eyes in the third specimen; width across eyes 1.25–1.4 mm.; eye length 0.65–0.75 mm. Clypeus semicircular, short, yellow to light brown, apically white and bilobed. Mandibles fairly large for a small lampyrid, 0.3–0.35 mm. across in closed position. Maxillary and labial palpi small and white.

Antennae 3.0 mm. long; mostly brown, but first two articles yellow in one specimen; rather slender.

Thorax ventrally pale to light brown.

Tergites all brown.

Ventral abdominal segments 2 to 6 brown; 7 dark brown or black.

Legs rather long; posterior pair 2.7–3.25 mm. long; pale; tibial spurs not discernible.

Figures.—Aedeagus: Pl. IV, fig. 54. Habitus: Pl. I, fig. 14.

Female not known.

Distribution.—Collected in February and March in the John Crow Mountains region, and in July in the Blue Mountains at 4,000–6,600 ft. Common. (This is one of the few Jamaican

species found on other Antillean islands; Mayaguez, Puerto Rico, in January.)

Type.—In British Museum (Natural History).

Microdiphot barberi Buck

Buck, 1947, Proc. U. S. Nat. Mus. 97 (no. 3210): 74–75.

Description prepared from that of Buck.

A very small lampyrid, very narrow, nearly cylindrical; elytra and most of abdomen black; pronotum widest at midlength, with arcuate basal and apical margins, and yellow to pink. Size, 4.6 to 5.3 mm. long, 1.0 to 1.1 mm. broad.

Pronotum 0.9×0.9 mm.; nearly flat, widest at midlength, narrowing equally to front and rear, resembling *M. cavernarum;* apical and basal edges bluntly arcuate; angles obtuse; glistening yellow with pinkish mottling, apical sixth dark brown; with a prominent row of small indentations close to apical and lateral margins; narrow median sagittal sulcus to apical fifth.

Scutellum flat, elongate, rectangular; light yellow, sometimes with a shallow median sulcus; mesonotal plates white with dark brown borders.

Elytra 3.7–4.3×0.5 mm. wide at humerus, narrowing to 0.4–0.45 mm. at basal fourth and then parallel to apical fifth where apical tapering begins, mostly in the lateral margins; slightly sinuate suturally, so that they are not in contact from about midlength to apices, which are apposed and dull; black or very dark brown, with white lateral and sutural borders.

Frons 0.29 mm. wide, flat, medium to dark brown; interocular margins parallel to slightly divergent; width across eyes 0.73 mm.; eye length 0.32 mm.; eyes protrude slightly beyond pronotal edge. Clypeus not visible; labrum apparently projects directly over the mandibles. Mandibles brown, very slender, about 0.3 mm. across in closed position. Maxillary palpi light to medium brown; labial palpi a little paler.

Antennae 2.5 mm. long; dark brown; articles markedly conical; terminal and penultimate articles sometimes slightly paler; articles 6 to 8 about twice as long as wide.

Thorax ventrally light brown.

Tergites darkening from 1 which is light brown to the black pygidium; latter broadly ogival, abruptly truncated, apical edge slightly emarginate and about $\frac{2}{3}$ the length of basal margin; 7 and 8 wider than the corresponding ventral segments.

Ventral abdominal segments darkening progressively from 1 which is light brown to 7 which is dark brown; 8 white, truncated; 9 white with slight apical darkening; 7 slightly emarginate and 8 with slight median notch.

Legs with coxae, trochanters, and femora light brown; tibiae and tarsi medium brown; tibiae with a circlet of about a dozen robust spurs on distal ends, and others on the outer surfaces.

Figures.—Aedeagus: Pl. V, fig. 59. Habitus: Pl. I, fig. 2.

Female not known.

Distribution.—Collected in July at Morces Gap, Blue Mountains, 4,600 ft.

Type.—No. 57319, U.S.N.M.

Microdiphot cavernarum Barber

Barber, 1941, Proc. Rochester Acad. Sci. 8: 13.

Description prepared from type specimen in the U. S. National Museum.

A very small, slender lampyrid; pronotum subquadrate; elytra dark brown with narrow lighter sutural borders, outer margins deflexed. Size, 3.0 mm. long, 0.75 mm. broad.

Pronotum 0.65 × 0.65 mm.; almost rectangular; pale, without markings. Scutellum white; mesonotal plates light brown.

Elytra 2.1 × 0.375 mm.; dark brown, shining, minutely asperate; very narrow yellow sutural borders; lateral margins deflexed and not expanded.

Frons pale, hairy; width across eyes 0.35 mm.; eye length about 0.18 mm. Clypeus semicircular, light brown. Mandibles light brown, about 0.18 mm. across in closed position. Maxillary palpi short, white, terminal article conoidal; labial palpi very small, white.

Antennae 1.8 mm. long, stout, cylindrical, pale brown.

Thorax ventrally light brown.

Tergites 1 to 3 white, 4 to 6 pale brown; shining.

Ventral abdominal segments white or pale; 8th luminous.

Legs pale.

Figures.—Aedeagus: Pl. V, fig. 60. Habitus: Pl. I, fig. 1.

Female not known.

Distribution.—The unique specimen was collected in April at Windsor Cave, in the western third of the Island, at about 1,000 ft.

Type.—No. 55650, U.S.N.M.

Photuris jamaicensis E. Olivier

Olivier, 1886, Ann. Soc. Ent. France, (6) VI: 58.

Description prepared from numerous specimens, including collections in 1952.

A medium size lampyrid with pale to light brown elytra bearing darker longitudinal vittae; antennae and legs relatively long. Size, 9.0 to 13.0 mm. long, 2.7 to 3.4 mm. broad. The larger specimens are usually females.

Pronotum about 1.75–2.0 × 2.25–2.5 mm.; outline parabolic; basal edge sinuate; angles rather acute and somewhat produced; usually a short median sulcus in basal half; not tumid; ground color pale yellow, usually with a median brown infuscation, broadened apically and evanescent toward the basal margin; this mark may be absent; eyes and frons project beyond the apical edge. The definite black vitta with lateral pink areas characteristic of the North American species of *Photuris* is absent.

Scutellum small, apparently triangular, yellow streaked with brown; mesonotal plates yellowish.

Elytra 8.0–11.0 mm. long × 1.3–1.75 mm. broad; parallel, apically narrowed; explanate margins very narrow, almost indistinguishable; ground color pale to light brown, typically with two longitudinal somewhat oblique brown vittae on each elytron, widest at basal end and narrowing apically, the submarginal vitta the longer; sometimes these vittae are much reduced, only the basal end of the interior one and about half of the submarginal one remaining; no distinct white borders.

Frons white, medially concave, hairy in some specimens; interocular margins very divergent; width across eyes about 2.25 mm.; eye length about 1.1 mm. Clypeus brown; apical edge may be strongly tridentate, or have merely a short median point. Mandibles sickle-shaped, longer and more overlapping than in *Photinus;* about 0.6 mm. across in closed position. Maxillary palpi brown; terminal article with a small apical projection; labial palpi small, very light brown, mitten-shaped rather than securiform.

Antennae mostly brown, article 1 partially paler; 4.5–5.0 mm. long; articles 2 and 3 shortest, 3 slightly longer than 2; 11 slightly bulbous; joints usually distinctly ringed white; base sockets very close together, about 0.05 mm. between inner edges.

Thorax ventrally yellow.

Tergites 1 to 4 light brown, 5 dark brown, 6, 7, and 8 white; 1 to 7 may be brown in some specimens; pygidium long-triangular.

Ventral abdominal segments 2 and 3 yellow, 4 yellow with some white medially, 5 mostly white; 8 with median point on apical edge; 9 triangular, white; posterior edges of 2 to 5 nearly straight; foveae usually not visible —in contrast to *Photinus* they are on the baso-lateral portion of the segment.

Legs with coxae white; femora yellow, except brown at "knees"; tibiae proximally pale, shading to light brown distally; tarsi brown; lobes of the 4th tarsal article short, reaching about half way to claws; the latter brown, the outer ones bifid; tibial spurs long, especially on the posterior pair,

pattern probably 0–2–2, but not easily seen on the meso-tibiae. The legs are proportionately very long as compared with *Photinus* or *Diphotus,* and the degree of infuscation rather variable.

Figures.—Aedeagus: Pl. VI, fig. 64 (very similar to that of the North American species of *Photuris*). Habitus: Pl. II, fig. 38.

Females very similar to male, but tend to be larger and paler and the elytral vittae less developed; active flyers. The area of the luminous tissue on ventral segments 6 and 7 is slightly less than in the male, a narrow brown border surrounding the luminous areas.

Distribution.—Available specimens were collected in every month except May and June, mostly on the plateau, but up to 3,500 ft. in the Blue Mountains, and some at sea level on the north coast; from Hector's River on the east coast to Montego Bay in the western third of the Island; probably distributed all over the Island and very common.

Type.—Presumably in the Olivier collection, Muséum National d'Histoire Naturelle, Paris.

(It is assumed that only one species of *Photuris* occurs in Jamaica. It is possible that there may be a second species, possibly the North American *P. versicolor,* the presence of which would not be surprising.)

Presbyolampis immigrans Buck

Buck, 1947, Proc. U. S. Nat. Mus. 97 (no. 3210): 76–77.

Description prepared from that of Buck and inspection of the type in the U. S. National Museum.

A small to medium size lampyrid with dark brown to black elytra having narrow white lateral and sutural borders; the luminous organs occupy only the median third or half of sternites 6 and 7; sternite 8 with long median point; pronotum short; both claws of each foot bifid. Size, 8.0 to 8.5 mm. long, 3.5 mm. broad.

Pronotum 1.6×2.7 mm.; apical edge blunt or produced to an obtuse median peak; lateral edges sub-parallel in basal half; angles acute, 60°; margins slightly reflexed laterally, markedly so apically; disk black, lateral borders white, apically light brown; surface glistening and roughly pebbled; vestiture fine, dark, and very sparse; basal edge sinuate.

Scutellum dark brown with light brown margins; mesonotal plates black.

Elytra 6.6×1.6 mm.; parallel to apical third, where they begin to narrow, mainly in the lateral margins; uniform dark brown to black, except for

very narrow white lateral and sutural borders.

Frons medium to dark brown, very concave, 0.6 mm. wide; vertex black; interocular margins very divergent, about a 30° angle; width across eyes 1.75 mm.; eyes elliptical, about 1.1 × 0.9 mm., and project somewhat forward of the pronotum. Clypeus short, brown, feebly bilobed. Mandibles brown, tips darker, rather small, 0.5 mm. across in closed position. Maxillary and labial palpi light brown to white.

Antennae 2.8 mm. long, medium brown; articles 2 and 3 sub-equal, ratio of lengths about 2.5 : 3.0; articles 6 to 8 each 2.5 times as long as wide, with rather long vestiture.

Thorax ventrally medium brown.

Tergites 1 to 6 medium brown; 7 and 8 laterally white; pygidium ogival.

Ventral abdominal segments 2 to 5 medium brown; basal border of 6 brown, 8 and 9 with some light brown areas; 6 and 7 feebly emarginate; 8 prolonged medially in a slender point overlapping the narrow 9th segment; luminous areas on segments 6 and 7 occupy only median third to half of the ventral surface (cf. *Photinus lucernula*).

Legs with coxae and femora white; tibiae and tarsi medium brown; tibiae thinner and less compressed than in typical *Photinus* and *Diphotus;* Both claws on all feet bifid, the inner points shorter than the outer; tibial spurs light brown, pattern 2–2–2.

Figures.—Aedeagus: Pl. VI, fig. 63. Habitus: Pl. I, fig. 26.

Female not known.

Distribution.—Three specimens collected in July at Morces Gap, in the Blue Mountains, 4,500 ft. altitude.

Type.—No. 57314, U.S.N.M.

(This species has some of the characters associated with the genus *Bicellonycha* of the Photurinae, especially the bifid condition of all claws; however, the aedeagus is not like that of *Photuris,* nor like those of two species of *Bicellonycha* which have been examined, these latter two not being particularly alike.)

Jamphotus tuberculatus Barber

Barber, 1941, Proc. Rochester Acad. Sci. 8: 11.

Description prepared from the type in the U. S. National Museum. Size, 17.0 mm. long, 7.0 mm. broad.

Pronotum 3.25 × 4.0 mm.; disk dark brown; basal margin nearly straight, the narrowly explanate lateral and apical margins nearly evenly rounded; disk shining, very coarsely and irregularly wrinkled, very finely punctulate, and pubescent; pale border, wide laterally and apically, narrow at basal edge.

Scutellum broad, more strongly punctulate than pronotum; apex obtusely notched; light brown; mesonotal plates dull light brown.

Elytra dehiscent, subtriangular, yellow, short, hardly reaching the first tergite and exposing most of the metanotum which is pale and marked with a dark brown band.

Frons brown, hairy, only slightly concave; interocular margins parallel; about 0.9 mm. wide; width across eyes about 2.1 mm.; eye length 0.6 mm., but 0.85 mm. vertically, i.e., elliptical with long axis vertical. Clypeus short, brown, tridentate. Mandibles large, about 0.95 mm. across in closed position. Maxillary palpi large, light brown; terminal article flattened on inner surface; labial palpi pale brownish, terminal article sagittate rather than securiform.

Antennae 2.5 mm. long, stout, brown.

Thorax ventrally pale brownish yellow.

Tergites 1 to 7 brown, the surface densely tuberculate with numerous irregular tubercles; posterior margins strongly tuberculate at outer angles and median thirds, forming four equidistant rows of teeth on the dorsal surface; reduced 8th segment trapezoidal, yellow, disk basally infuscate, apex truncate, feebly bisinuate; hind angles acute, sides sinuate; each tergite has a narrow, apically broader, median stripe and a broad, triangular, pale yellow spot at each hind angle. Abdomen broad with a fine, median, dorsal carina.

Ventral abdominal segments 2 to 6 brown; 7 almost wholly pale, the subcutaneous white reflector emarginate basally and apically, but extended laterally beyond the submarginal fold as supplementary luminous areas in the pleural area below the spiracles; 8 and 9 also pale, but without the subcutaneous reflector layer.

Legs short; claws simple.

Male not known.

Figure.—Habitus: Pl. III, fig. 47.

Distribution.—Collected in July at Morces Gap and Catherine's Peak in the Blue Mountains. One larva collected in October at Portland Gap; all collections at 4,500–5,600 ft.

This remarkable apterous female cannot at this time be placed in any previous genus. Barber tentatively suggested that it might be the female of *Photinus euphotus* or of *P. amplus,* but the larviform female of the former is represented in the collection of the Institute of Jamaica, and the alate female of the latter is now known. The larval specimen resembles Barber's description of the adult female except for the absence of rudimentary elytra and the presence of a brush of anal filaments.

Holotype.—No. 55642, U.S.N.M.

Lecontea (Pyractomena) gamma Jac. Duval

Jac. Duval, 1857, In Sagra, Hist. Cuba, VII, p. 85.

Description prepared from Cuban specimens in the U. S. National Museum, one identified by E. Olivier; also one collected by Dr. Thomas H. Farr at Whitehouse Bay, Jamaica.

A small lampyrid with a yellow pronotum bearing four broad brown vittae; elytra brown with yellow lateral borders and costal vittae. Size, 7.5 to 8.7 mm. long, 2.5 to 3.0 mm. broad.

Pronotum 1.5–2.2 × 2.3–2.5 mm.; decidedly narrowed apically and slightly narrowed just forward of the posterior angles, which are acute but not produced; disk distinctly convex and finely granulate; borders coarsely punctate; vestiture short; a median yellow vitta with a low carina in the anterior half extends from the apex to the base; on each side of this there is a wide, nearly black, stripe not quite reaching either base or apex; then a somewhat irregular yellow streak, slightly pinkish in the basal portion, and a second shorter and less regular dark brown vitta; narrow basal and wider lateral and apical borders yellow; lateral margins reflexed, apical margin less so.

Scutellum basally brown, apical half yellow; or entirely light brown; mesonotal plates dark brown.

Elytra 5.4–6.9 × 1.25–1.5 mm.; parallel; narrow explanate margins of uniform width to apices; finely granulate, with short, light vestiture; lateral and narrower sutural borders a rather dark yellow, as are also the vittae which mark the two slightly oblique costae, the outer one of which nearly reaches the apex, while the inner one reaches to about one-half the elytral length. The general effect is that of four dark brown stripes separated by yellow lines.

Frons dark yellow, and may have a median brown spot; nearly flat, prominent just above the antennal sockets; interocular margins nearly parallel; width across eyes about 1.5 mm.; between eyes 0.55 mm. Clypeus short, reddish to dark brown, semicircular or somewhat emarginate. Mandibles brown, about 0.3 mm. across in closed position. Maxillary palpi dull brown to black; terminal article short, outline conoidal, apex acute; labial palpi very small, black, securiform.

Antennae 1.6–2.2 mm. long; brown to black, the two basal articles lighter, the first being nearly $\frac{1}{5}$ of the total length; 3 to 6 may be noticeably thicker than the others; hairy.

Thoracic segments practically black laterally, yellowish brown medially.

Tergites all dark brown to black, including pygidium.

Ventral abdominal segments 2 to 5 medially light yellowish, laterally dark brown; 6 and 7 luminous, yellowish orange, and about 1.5 times as long as 5; 7 and 8 subequal in length, median third brown; lateral thirds mottled ivory.

Legs with basal ½ to ¾ yellow, remainder brown to black; tibiae black in dorsal aspect, dark yellow beneath; tarsi black; tibial spurs very small, pattern apparently 0–2–2.

Figures.—Aedeagus: Pl. VI, fig. 66. Habitus: Pl. II, fig. 30.

Female similar to male, with proportionately wider pronotum, smaller eyes, and reduced luminous areas.

Distribution.—Described from Cuba; one specimen collected at Montego Bay, northwest coast, in March, and one at Whitehouse Bay, southwest coast, in July. It is one of the few species collected in Jamaica which is found elsewhere in the Antilles.

Type.—Presumably in the Olivier collection Muséum National d'Histoire Naturelle, Paris.

V. General Comments on the Distribution of the Lampyridae in Jamaica

The Island of Jamaica, roughly 145 miles long and 40 miles wide, has about as varied habitat conditions as could be compressed into an area of 4,500 square miles. In the eastern third the Blue Mountains rise to 7,400 feet, and for thirty miles form a lengthwise barrier never less than 3,000 feet high. On the north side of this ridge the rainfall may be 200 inches or more a year, resulting in a rain forest (Shreve, 1914), while the opposite south coast may get ten inches or less of rain and in some places supports a typically desert fauna and flora. There is also a small area of heavy rainfall in the northwest portion of the Island. From the western end of the Blue Mountain region lower ridges extend almost to the west coast. These ridges form the apex of a limestone plateau 1,000 to nearly 3,000 feet high, the limestone deposit itself, mostly of Miocene age, being 1,500 to 2,000 feet thick and much corroded into caverns, dolinas ("cockpits"), and underground water courses. Other spur and independent ridges, sometimes reaching the coast, cut the plateau into rather definite areas. The soils vary from the marshes and mucklands of the hot coastal regions, through thin and relatively infertile limestone soils of the plateau, to the probably acid soil of the Blue Mountain Peaks. The temperature at sea level is normally fairly constant in a range of 70° to 90° F., the average vary-

ing somewhat with the season. The seasonal mean temperature decreases with altitude until near frost conditions may be reached on the Blue Mountain Peaks in winter. Only about 8% of the total area can be classed as level, most of this being in the coastal portions.

At least the later geologic history of the Island is fairly well known (Moore, 1930; Schuchert, 1935; Darlington, 1938). There is no evidence of land-bridge connection with continental land masses since the Miocene, in the earlier part of which period the sea level was at a point now some 3,000 ft. high on the Blue Mountains. Jamaica has apparently had many ups and downs, as have the neighboring islands Cuba and Hispaniola, the latter having probably been connected with Jamaica at one time. Today the nearest point of continental land is Cape Gracias a Dios, between Honduras and Nicaragua, 400 miles to the west-southwest. Florida is about the same distance north, but Cuba, 95 miles away, intervenes. Venezuela is 500 miles to the south, and an edge of Colombia somewhat nearer to the southwest. Hispaniola lies 125 miles to the east-northeast. Thus it would seem that the endemic fauna may be largely the descendants of forms which survived the Miocene submergence and the Pleistocene refrigeration. In view of the known ocean currents, trade winds, and the prevalence of hurricanes whose scope may simultaneously involve the adjacent islands and possibly occasionally the edges of the continents, it is rather remarkable that of the known Lampyridae of the Island only two species, *Lecontea gamma* of Cuba, and *Diphotus unicus* also found in Puerto Rico, are found elsewhere in the Antilles, and of the former only two or three specimens are known to have been collected in Jamaica. It is not improbable that the larvae collected by McDermott (1953) are those of *L. gamma*. (Another species, *Diphotus glaucus*, of Hispaniola, has been reported from Jamaica, probably erroneously.) Of course the Jamaican species of lampyrids have generic similarity to those of the surrounding islands and adjacent continents, but aside from those just mentioned no instance of identity or synonymy has come to the authors' attention. The rather remarkable absence of *Lucidota, Callopisma, Aspisoma,* etc., abundant on the continents or on other Antillean

islands, seems to indicate that the ingress of species described from other localities is rather a rare phenomenon.

Assuming that the majority of the lampyrids now found in Jamaica are the descendants of the survivors of the Miocene and Pleistocene conditions, there should be some evidence of evolutionary changes, even if the sequence of the process is not traceable. This seems to be true in a few of the species, particularly in the *Photinus lobatus–P. evanescens* group, where differentiation has not progressed to a point sufficient for facile taxonomic recognition. The varieties of *P. evanescens* have been discussed by Buck (1942), and some of the other species-complexes in *Photinus* may be indicative. In *Photinus* the aedeagus exhibits several modifications of a basic pattern with a general similarity between most of the species, but in *P. pallens* and *P. xanthophotis,* the two largest species, this structure shows rather more variation from the basic type, which may indicate that they are not entirely in the same evolutionary line. *Diphotus,* which in habitus greatly resembles *Photinus,* has a quite different aedeagal pattern and one subject to rather wide variation. The great similarity of the aedeagus of *D. bucki* to that of *D. masti* suggests the possibility of a geologically rather recent separation, and resembles the aedeagal similarities among the North American species of *Photuris* (Barber, 1951). The majority of the species of *Diphotus* are alticolous—even acrophilic—and more or less limited to the Blue Mountains region, but one, *D. ornicollis,* is found at lower altitudes and so far only in the western two-thirds of the Island. Most species of *Diphotus* are 7 to 12 mm. long, but one, *D. unicus,* is definitely smaller. It may be noted that so far as known at present, this genus is restricted to the Antilles. While some species of *Photinus* show alticolous preferences, the majority are found only below 5,000 ft., and relatively rarely above even 2,500 ft.

Microdiphot, like *Diphotus,* has the luminous organs on the eighth sternite, and is apparently related to the latter genus, but the very narrow form suggests adaptation to a specific habitat or mode of life (cf. *Cylindrosella;* Barber, 1924). In 1941 Barber said of *Microdiphot cavernarum* that it ". . . suggests almost recent development of cavernicolous forms in the subterranean drainage systems which honeycomb this great 1500-ft. layer of

limestone." This genus has so far been found only in Jamaica.

Photuris jamaicensis differs so little from some North American species of the genus, even in the aedeagus, as to indicate very close relationship. Degeer (1794) and Gosse (1851) both regarded it as a North American species. At least two distinct types of light emission have been noted in otherwise indistinguishable males, these being similar to the differences between the North American species *P. versicolor* and *P. hebes*. Some of the females respond to the male flash as do those of *P. versicolor*, while others give a very long coruscation unlike anything so far reported in the North American species.

Presbyolampis immigrans is specific in so many characters as to show no close relationship with the other Jamaican lampyrids, but the bifid claws, antennal structure, and incompletely covered head indicate position in the Photurinae. Its alticolous habitat and the absence of a known female make it impossible to draw any conclusions as to its origin; nor does it show more than a suggestive resemblance to known forms from Honduras. It may be either the descendant of a mountain-top survivor or an adventive of many years ago. *Jamphotus tuberculatus* is likewise a puzzle. Here the absence of a known male complicates the picture, but it does seem unlikely that a species having an apterous female could have been brought in recent times to a region at an altitude of 6,000 ft. It may perhaps be a lineal descendant of one of the survivors, but it may have acquired the apterous condition more recently.

While the emergence of the land areas following the subsidence in the early Miocene, the formation of soil, and the spread of vegetation took hundreds of thousands of years, it would seem that insects in which both sexes are alate, like *Photuris* and many of the species of *Photinus* and *Diphotus*, should have been able to spread over an area such as Jamaica in a period equivalent to not over 100 years.[15] The spread of those

[15] Thus the Japanese beetle, *Popillia japonica*, has spread over an area in the United States wider than Jamaica and several times as long, in the course of about 50 years, with relatively little human assistance, though so far without crossing mountain barriers in numbers. *Leptinotarsa decimlineata*, the potato beetle, and *Epilachna varvivestris*, the Mexican bean beetle, have covered much larger territory than this in 100 years or less, although more or less aided by agriculture. Even species with flightless females, such as *Photinus scintillans*, are found over large areas in North America.

with flightless females would be slower, but there has evidently been ample time since the Miocene for all of the species of Jamaican lampyrids to have sampled the various habitat conditions on the Island, and that they are not uniformly distributed can be attributed mainly to differing biologic requirements.

The general distribution of each species, so far as known at present, has been given at the end of the description of the species, and it will be noted that while some species are ubiquitous, or at least very widely distributed both geographically and seasonally, others are more or less restricted to one or the other ends of the Island, to lower or higher altitudes, or, less definitely, to some season of the year. The records are admittedly spotty, much depending on the times of the year and the territory covered by visiting biologists. The large number of specimens and of species collected by Buck, mainly in the Blue Mountains region in July and August, give this time and place undue prominence, even in view of the large collection at the Institute of Jamaica. A curious hiatus is the absence of collection of most species in May, only the very large *P. xanthophotis,* the small *P. evanescens,* and the ubiquitous *P. synchronans* being represented by specimens collected in May. It is probable that some of the commoner species—e.g., *P. pallens, P. synchronans, Photuris jamaicensis*—are in flight in some part of Jamaica throughout the year. Director C. Bernard Lewis of the Institute of Jamaica, writes, ". . . from my own experience I can say that although there is a normal seasonal fluctuation and prevalence of different species (of fireflies) this can be markedly irregular locally. Lampyrids are most abundant in the hills during July and August, while they are most abundant in the low lands during October and November. In the vicinity of Kingston, for example, we rarely see a firefly except during the October and November period, when they may be most abundant. When . . . and . . . visited Jamaica (in 1950) they came in February and reported no fireflies at all on the north coast. We found 6 or 8 species flying at Ferry, about 5 miles west of Kingston . . . they found one or two species abundant at Irish Town, on the way to Newcastle." However, in January and February, 1952, McDermott found fireflies of several species fairly abundant at Port Antonio

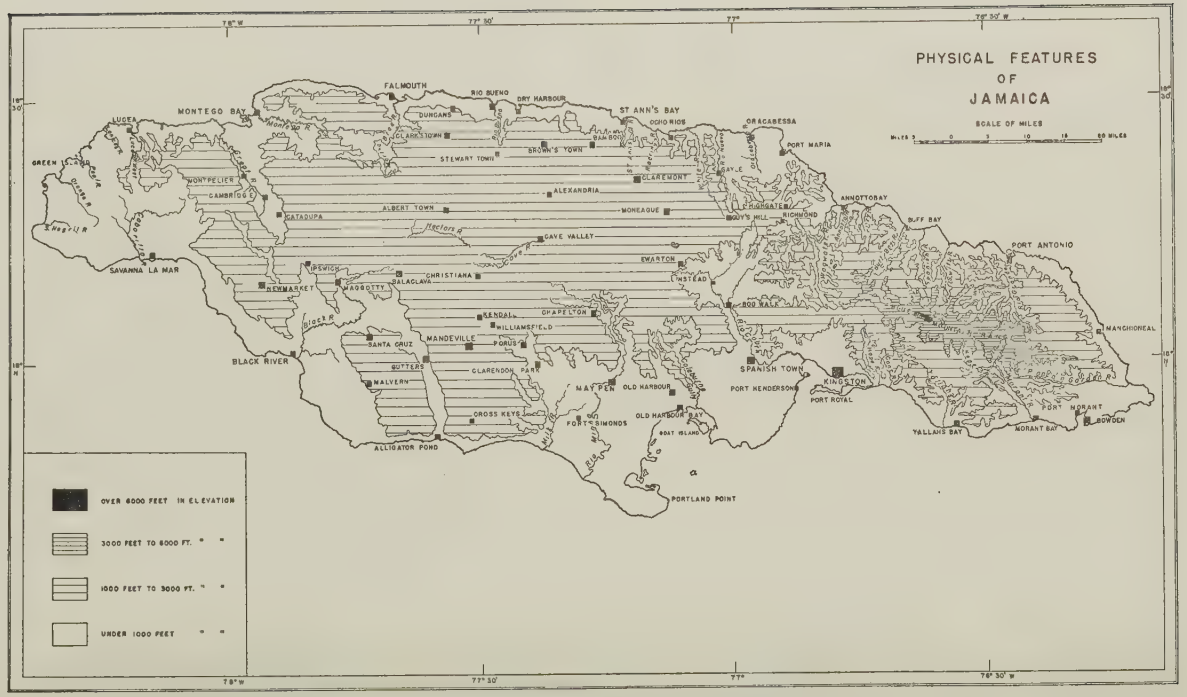
and St. Ann's Bay, on the north coast, but only scattered specimens at Whitehouse Bay on the southwest coast, and none at all at Ferry in March.

Mr. G. R. Proctor of the Institute of Jamaica has called our attention to the presence in the relatively low John Crow Mountains of plant species usually associated with altitudes 2,000 ft. higher in the Blue Mountains. The same seems to be true for some of the fireflies. This may to some extent be a temperature effect, as they seem to appear in the lower levels earlier in the year than on the heights.

While it is not possible to draw any definite conclusions from this study of the distribution of the various species of lampyrids in Jamaica, with reference to their phylogeny and derivation, it does appear that for the most part they are today strictly autochthonous. The number of species surviving the Pleistocene, and the number which may be relatively late adventives, remains problematic. From the evolutionary point of view some of the groups are still plastic, and the non-uniform distribution is probably the result of biologic adaptation to local conditions of temperature, humidity, and soil, probably mainly because these factors affect the presence of suitable prey.

It may be noted that Zimmerman (1948) concluded from his study of the insects of Hawaii that all of the 1220 endemic species of coleoptera could have been derived from 223 to 254 original immigrants; the 222 endemic species of Carabidae could have been derived from 4 to 6 immigrants; and all of the 164 species of *Proterhinus,* all flightless, from a single immigrant species.

The accompanying map of Jamaica is Plate II of "The Geology and Mineral Resources of Jamaica" by H. R. Hose (1950), and is used by the kind permission of Dr. Hose. The altitude contours delineate the areas where the various species have been found as given with each species description.



Map. 1.—The island of Jamaica showing altitudinal variation.

VI. Flashing Patterns and Courtship Signals

Like the songs of birds and the calls of frogs, the flashes of different kinds of fireflies show many differences which may be easily recognized. McDermott (1911, 1912, 1914) studied the subject in several North American species of *Photinus* and showed that the flash patterns of the males were highly constant and definitely characteristic of the individual species. From the collector's point of view, flash patterns may be very useful in field identification, or even, as in the American *Photuris* complex, of critical taxonomic importance (Barber, 1951). From the biologic viewpoint there is good evidence, again from North American forms, that the flash patterns are associated with signal systems by which the sexes are brought together for mating. It is unfortunate that collectors have almost universally failed to note—or at least to record in print—the luminous conduct of the lampyrids they collected.

Courtship signals have actually been analyzed in detail only in the single North American species *Photinus pyralis* (Osten-Sacken, 1861; Mast, 1912; Buck, 1937) but there is strong evidence that similar systems occur in other species (McDermott, 1911; 1914). In *P. pyralis* the male searches actively for the female which remains at rest on the vegetation and flashes only in response to the flash of the male. Recognition of the female by the male depends on her responding always at a precise time interval after his flash. Thus the female of *P. marginellus* has been seen to respond to the flash of a male *pyralis* flying above her but this response was immediately after his flash and he paid no attention to her. In *Photuris versicolor*, in which both sexes fly actively, the mating signal system is more difficult to analyze but follows the same general pattern as in *pyralis*.

In those species which flash there are several factors which may differ to allow the different species to identify their proper mates. As noted, habitat is important, typically alticolous species not usually being in contact with populations at lower altitudes; forest or tree top species do not mingle with those that prefer open meadow-land; those that fly late in the evening are not apt to encounter those which appear earlier, etc. But aside

from these geographical or temporal differences, which are rarely if ever absolute, there is a range of physical characteristics which makes the signal systems more or less specific. These are (1) the pattern of the flash; (2) the character of the individual flash, whether steady or flickering; (3) the time interval between successive flashes or groups of flashes; (4) the brilliancy of the emitted light; (5) the color of the light; (6) the time interval between the flash of the male and the response flash of the female; and (7) the flight characteristics of the species. There may, of course, be other factors not perceptible to the human senses, but obviously within the ranges of these characteristics a wide variety of specific conducts can be embraced, and even if any one factor varied over a relatively broad band, the over-all conduct would still be specific for that species. These factors are discussed separately below.

1. Flash Pattern. Obviously the simplest flash is a single coruscation, the length of which varies with different species. In this class are *Photinus alticola*, some *P. amplus*, some *P. ceratus*, *P. euphotus*, *P. gracilobus*, *P. lobatus*, *P. naevus*, *P. pallens*, *P. synchronans*, and *P. xanthophotis*. In *P. lewisi* and *P. morbosus* these single flashes are of a full second duration, and in *P. pallens* of 0.5 second or more, but usually the length of a single flash is very short, 0.1 second or less to 0.25 second.

Next in complexity would be flashes composed of two or more components. Thus most *P. amplus* specimens gave a 2-component flash, with a distinct interval between the components. *P. ceratus* usually gave a similar double flash, somewhat less brilliant than that of *amplus*, and with an appreciably shorter interval between the components. One specimen of *ceratus* gave a 4-component flash, apparently a doubling of the usual double flash. Only the exceptional specimen of *Photuris*, noted below under color, was recorded as giving a definite 3-component flash. In some species—*P. flavolimbatus*, *P. melanurus*, *P. variabilis*, and some *P. leucopyge*—the basic flash is apparently single but is emitted in groups of varying numbers of components, in *melanurus*, for example, from 5 to 11 in very rapid succession but not necessarily with a fixed spacing. Two specimens of *P.*

evanescens were taken giving series of 20 to 30 very short flashes in rapid succession. Some other variations suggest the development of subspecific behavior variants, e.g., *P. pallens* from the Blue Mountains differed somewhat from those from Mandeville.

2. Flash Character. In a few species the flash is definitely flickering or twinkling, e.g., *Photinus commissus, P. elisabethae, P. evanescens, P. evanescens var. dubius, P. morbosus, P. nothus,* and *Photuris jamaicensis.* In some other species the flash has sometimes been seen as, or is suspected to be, a very high-frequency flicker as in *Photinus xanthophotis catherinae, P. synchronans,* and *P. lundi.* At a distance this type of flash may appear to be simple, the flicker not being distinguishable. Flicker discrimination at a given light intensity seems to be somewhat better in more peripheral vision. For example, the high-frequency flicker of *P. xanthophotis catherinae* is more easily seen " out of the corner of the eye."

3. Interval Between Flashes. Usually there is a more or less definite " rest " period between flashes or groups of flashes varying from about one to ten seconds or more, correlated somewhat with the habitat and terrain. When possible, these intervals have been timed and the values found are recorded with the other data on the accompanying diagrams. These intervals are fairly constant intraspecifically under fixed conditions, but vary with the temperature, and possibly with the humidity and atmospheric pressure. Occasionally dim sparks or glows are interspersed between the main flashes.

4. Brilliancy of the Light. This doubtless plays some part in the selectivity of the signal system, but in general brightness varies with the size of the insect, as might be expected. The two largest species, *Photinus pallens* and *P. xanthophotis,* give " blinding " flashes when seen at close range while small species such as *P. harveyi* and *P. nothus* give rather weak flashes. As in the North American species, *Photuris jamaicensis* appears to give a brighter light than *Photinus* of corresponding size.

5. Color of the Light. In this factor we find the field rather beset with uncertainties. It has been shown spectrophotographically by Buck (1941), that the color of the light emitted by different species actually differs. And it has been recognized

for many years that there is a difference in the color of the light of some North American species. While in all cases the spectral maxima fall close to 5800 Å., the energy distribution results in somewhat different over-all colors which might be given as orange-yellow, yellow, greenish yellow, and greenish, or even green. (No distinctly reddish flashes were noted among the Jamaican Lampyridae.)

While these color differences may be of some use in the field, the effects of background, general illumination (cf. Gosse, 1851, p. 104), the varying sensitivity of the human eye to dim light, individual sensitivity to color, etc., lead to confusing and sometimes contradictory records. Hence, we are listing below only those species in which all records indicate the same color, restricting the classification to " yellowish " and " greenish ".

Yellowish	Greenish
Photinus	*Photinus*
amplus	*evanescens*
blackwelderi	*evanescens var. dubius*
ceratus	*lewisi*
flavolimbatus	*lobatus*
euphotus	*nothus*
leucopyge	*synchronans*
morbosus	*Photuris jamaicensis*
naevus	*Diphotus montanus*
pallens	
variabilis	
xanthophotis	

A single specimen of *Photuris* was taken giving a triple flash similar to that of the North American *P. versicolor* but of a distinctly orange tinge. The light of *Photinus commissus* appears to one of us (McD) as " coppery ", while other records refer to it as orange, or even greenish. This may indicate the difficulty of assigning a definite color to a flash seen in the field. From the chemical standpoint, a color variation within a species would be very unlikely.

6. The Inter-Sex Interval. Observations on courtship signals in Jamaican fireflies are disappointingly scarce in comparison with those on American species. This is partly due to the profusion of species in Jamaica. Thus, where *P. pyralis* can be studied in pure populations of hundreds of individuals, most Jamaican habitats have smaller numbers of several species active simultaneously. Further obstacles are the absence in the Tropics of the long twilight period during which the insects may be observed in flight even while not emitting light, and the severe restrictions imposed on the observer's movements by jungle trails. No instance of a complete cycle of courtship signals ending in mating has been observed in any species, even in the presence of females in situations which appeared to be ideal for signalling. In two common Jamaican species of *Photinus* the apparently normal courtship flashes have been observed in both sexes, and in another the responses to a flashlight have left little doubt as to the signal system. In *Photinus synchronans* the female response to the male flash has been observed, although actual mating was not. In general, the conduct was much like that of *P. pyralis,* even to the reported synchronism of large populations of males (Miller, 1935), but the female response is given with very little delay after the male flash instead of after a pause of the order of two seconds as in *pyralis.* Attraction of the males to a flashlight shielded with green cellophane and operated in imitation of the female flash was obtained, though rather less effectively than with *pyralis,* and no response of a female to a flashlight could be elicited. The response of the females of *P. pallens* to the flashes of passing males has also been seen, but in none of the observed instances did the males find the females. With *P. alticola,* females responded by flashing 1.1 seconds after a flashlight operated in the same manner as the male of *P. pyralis,* and the male came to a flashlight flashed immediately after his flash.

In addition to these fairly definite instances, other suggestive records are as follows:

A male *P. evanescens* was seen to swerve toward the flash of a female during his long twinkling flash, and a male and female of

this species were seen signaling by single flashes on the grass.

The sexes of *P. xanthophotis catherinae,* 10 inches apart on fern, were giving flashing signals, usually not correlated but several times one (the female?) flashed just before the flash of the other was over.

A male of *Photuris jamaicensis* came to a flashlight flashed alternately with his flashes. In this species, also, males flying over sugar-cane and giving single flashes at 2 second intervals were apparently answered by low-perching females giving a less brilliant flash much as in *P. versicolor.* A female of this species apparently answered and partially lured a male of *Photinus pallens.*

Males of *Photinus melanurus* and *P. leucopyge* showed some tendency to come to a light flashed after their flashes.

We have not included numerous flashing records from females (nearly all of which were at rest, since *Photinus* females even when alate rarely fly), first, because species identification could not always be certain and, second, because the light, if emitted spontaneously, is almost always given as non-specific single flashes at irregular intervals. In the North American species so far studied, the females appear to flash usually only in response to the flash of a male. In Jamaica the females of *Photinus pallens, P. synchronans, P. blackwelderi,* and *P. melanurus* were observed to give seemingly normal flashes apparently without stimulus of a prior male flash. The flashing of males at rest is also usually irregular and different from the pattern in flight. The flashing of immobilized specimens for laboratory study is also irregular and atypical. Two females of *Photuris jamaicensis* have been observed to give the long glow described by Gosse (1851). It is, of course, possible that the males give their normal courtship flashes only when in localities where they may expect the females to be present, and to give irregular and non-characteristic flashes at other times.

7. Flight Characteristics. Fireflies differ specifically in flight characteristics, though our knowledge is for the most part so fragmentary that only a few representative species can be mentioned, mainly to call attention to areas needing investigation. In considering the times of activity it must be remembered that firefly activity is greatly inhibited by fog, breeze, and moon-

light, so that quite atypical behavior may result on certain evenings. Furthermore, a given species appears earlier in deep shade than in open fields and may concentrate in local populations so that care must be taken not to conclude from predominance in a particular area that the same species would necessarily predominate elsewhere at the same time. Even in view of these qualifications, however, and in spite of the suddenness of the tropical nightfall, some species show clear indications of activity periods such as have been found in *Photinus pyralis* to be correlated with environmental temperature and light intensity, and also to involve an inherent diurnal rhythmicity (Buck, 1937a). Perhaps the most striking is *Photinus euphotus*, an inhabitant of the mountain forest areas, which appears to be active for a period of only 15 to 20 minutes just at dusk (7:00 PM at 18° C., in July and August). *Presbyolampis* apparently has similar habits. At lower altitudes *Photinus pallens* and *P. variabilis* are among the earliest species to flash. Within the first hour of the evening the following additional species are normally active: *P. alticola, amplus, xanthophotis catherinae, ceratus, elisabethae, evanescens, gracilobus, lobatus, leucopyge, melanurus,* and *synchronans, Photuris jamaicensis, Diphotus montanus,* and *D. unicus.* Species which are not usually seen in numbers before 8:00 PM and have their peak activity between 8 and 10 PM are: *Photinus commissus, flavolimbatus, lewisi, naevus, nothus, Diphotus semifuscus,* and *D. bucki.* From midnight into the early morning hours, only *P. commissus, pallens, variabilis, synchronans,* and *D. montanus* have been seen in numbers. *P. commissus* seems to be the only species active in moonlight.

Height of flight is another characteristic which varies greatly with individual and environment, and also with time, since a given species tends to fly at a greater average height as the evening advances. However, high flight has been especially noted for *P. amplus, commissus, elisabethae, naevus,* and *D. unicus.* Flight speed, with similar reservations, has been recorded as slow for *P. commissus, evanescens, lobatus, leucopyge, melanurus,* and *xanthophotis catherinae,* and as fast for *P. amplus, gracilobus, naevus,* and *D. unicus.* Hovering has been observed in *D. unicus* and in *P. gracilobus, leucopyge,* and *ceratus,* the latter

sometimes dipping during flashing like the American *pyralis*.

Activity after mechanical disturbance is of practical importance in collecting since some species drop instantly to the ground at the first touch and lie without any luminescence, while others when knocked down run about flashing. *Diphotus unicus*, for example, can often be found where its presence is otherwise unsuspected, by beating bushes. *P. evanescens* and *pallens*, *D. montanus* and *semifuscus*, and *Photuris jamaicensis*, are particularly active in captivity, whereas *P. alticola*, *ceratus*, *flavolimbatus*, *gracilobus*, *leucopyge*, *lewisi*, *naevus*, *variabilis*, and *xanthophotis catherinae* are either much more placid or actually seem to feign death.

The remarkable phenomenon of synchronous flashing (see Buck, 1938) has been described by Miller (1935) for a Jamaican species, *Photinus synchronans* [16] while this has not been seen by either of the authors, many other occurrences of it have been reported by members of the Natural History Society of Jamaica. The phenomenon as described by Miller is rather similar to what may be observed in large populations of the North American *P. pyralis* but may be more definite than in the latter species, and is presumably the result of the nearly constant time interval in the flashing of the males of these species.

Usually lampyrids show little or no attraction to a constant light, but Gosse mentions that several species came into the house—presumably lighted by candles—at night, and in our experience females of *P. commissus* and *blackwelderi*, both sexes of *synchronans*, and a male of *D. montanus* have been taken when attracted to house lights. *P. synchronans* was frequently found in the house after the lights were out. The occasional instances of luminous fireflies being taken in full daylight are of interest *Diphotus flavomarginatus* and *D. pantoni* have been taken in flight in the daytime, and several specimens of *D. montanus* were found assembled on *Polygonum chinense* at Clydesdale in August.

However, in spite of variations such as the presumably less discriminatory type of communication in *Diphotus*, the occurrence in *Photinus pallens* of aggregations in which mating ap-

[16] Originally doubtfully identified by Barber as E. Olivier's *P. maritimus*; after examination of Buck's 1936 collection, he named it *P. synchronans*.

parently depends on propinquity (Buck, 1937c), and the quasi-synchronism of *P. synchronans*, our records of the response of one or both sexes to artificial signals from a flashlight, and observations on incomplete mating attractions, strongly indicate that most, if not all, Jamaican fireflies find mates by means of luminous signals. Therefore the qualifications discussed above should not be allowed to obscure the really remarkable intraspecific constancy of the flash patterns, enabling the observer to recognize many of the species in free flight. As always in such partly subjective matters, the ingredient of experience bulks large, and although the authors would undertake to identify most of the species included in the diagrams on the basis of flash alone, the decisions would also involve a background of hundreds of observations on what species are usually found together in a given locality and the individual species characteristics in regard to speed, course, and height of flight, color of light, period of evening activity, season, and other factors. However, it is interesting and perhaps highly significant that usually no two of the eight or ten species which may be active simultaneously in a given area have flashing patterns which are likely to be confused with one another. Thus the patterns of *Photinus harveyi* and *P. melanurus* would be distinguishable, if for no other reason, by the fact that these species do not overlap in distribution.

Data on the most frequently observed and presumably normal flashing characteristics of the males of 23 species, with varieties, of Jamaican fireflies are summarized in diagram 1. They employ the notation used by McDermott (1914) in which the abscissa is the time scale and the ordinates a scale of relative or comparative intensity. Actual stopwatch measurements were made for the most part only on the length of the flashing cycle, and that in only the few species shown. The time relations change somewhat with the temperature (Snyder and Snyder, 1920, and Buck, 1937a) and possibly with other factors. A few attempts were made to time individual flashes or groups of flashes, the results being included in the diagram of flash patterns (diagram 1). Nevertheless the flash patterns of the various species are indicated reasonably accurately on a comparative basis. It should be emphasized, however, that the diagrams have no exact

quantitative significance or value. Thus, although it is not to be concluded that the flash of *Photinus pallens,* for example, is exactly twice as bright and lasts four times as long as that of *P. evanescens,* it is correct to conclude that it will appear very much brighter under comparable conditions and will last considerably longer.

The diagrams show the remarkable differences in flash pattern which have been achieved by varying the three parameters of intensity, duration, and interval. Without resorting to individual descriptions, attention may be directed to (1) the intensity range between the "blinding" flashes of *P. pallens* and *P. xanthophotis* and the relatively dim signals of *P. harveyi;* (2) the leisurely flashing of *pallens* and the sharp flash of *amplus;* (3) the single flashes of *pallens, synchronans,* etc.; (4) the multiple flashes of *harveyi* and *variabilis;* (5) the twinkle or flicker of *nothus* and *Photuris jamaicensis;* and (6) the complex patterns of *Photinus evanescens* and *P. ceratus.* The frequencies of the flicker pulse are too high to be exactly represented graphically and might be expected to be recorded differently by different observers according to their ocular intensity-and flicker-frequency discrimination.

The diagrams give one flash or group of flashes for each species or variety and the interval in seconds between the main flashes. The species of *Diphotus,* in which the light is emitted as a long-sustained glow rather than in abrupt flashes, are, of course, omitted. While Buck's observations were made during June to August and McDermott's during December to March, there is no clear evidence of seasonal variation other than may be expected from temperature differences.

Explanation of Diagram 1.—The patterns diagrammed represent the most common or "average" type for each species or variety of firefly. Indicated intensities (vertical axis) and flash shapes are intended to be of rough comparative value only. Flash durations and interflash intervals are similarly estimated and, doubtless, vary widely with temperature, wind, terrain, etc. A few (Nos. 2, 6, 7, 9, 16, 21, and 23) are based on stopwatch records. "Interval" indicates the time from the start of one flash (pattern) to the start of the next. The intercalated flashlets

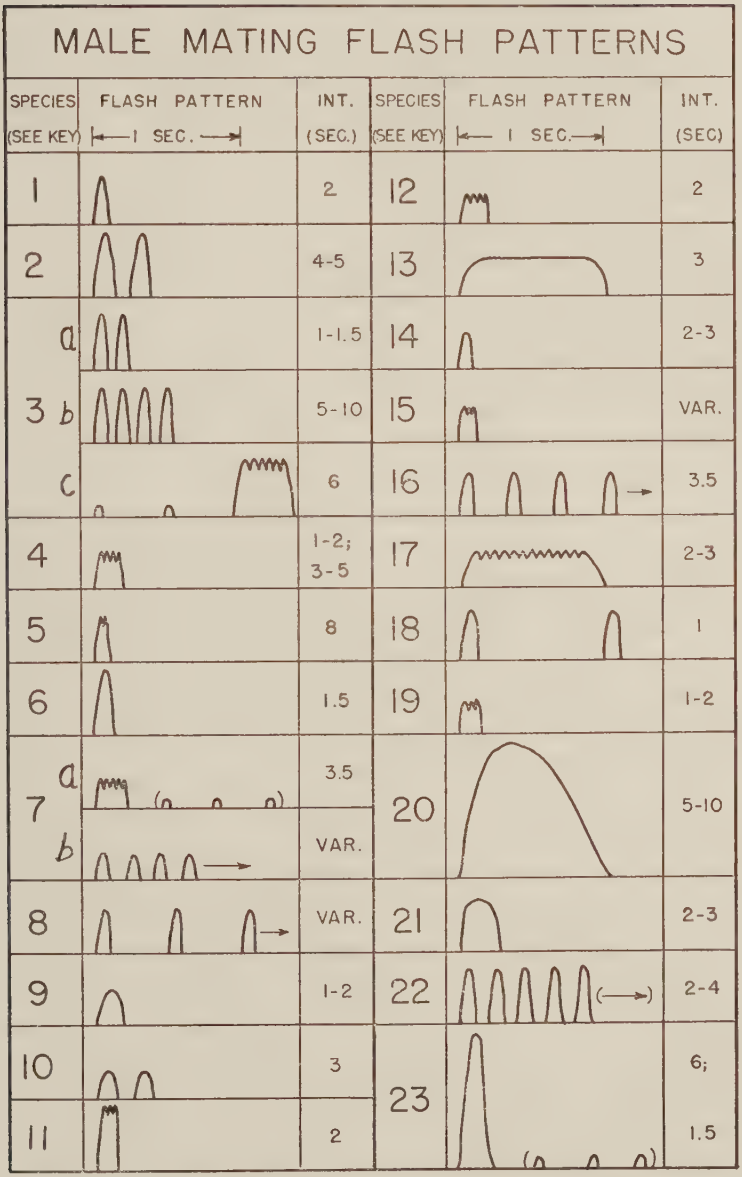


Diagram 1.—Mating flashes of the males of 23 species of Jamaican Lampyridae.

have been diagrammed according to whether they seem to occur closest to the start (No. 3c) or finish (Nos. 7, and 23) of the main flash. Arrows (Nos. 7b, 8, 16, and 22) indicate that the pattern may continue indefinitely in some individuals. Individuals of several species have been seen to show a dim residual glow between flashes. Diagram 1 refers to the species of *Photinus* except for *Photuris jamaicensis*.

No. 1—*alticola*. No. 2—*amplus;* two records of single flashes; conduct similar to that of the North American *P. consanguineus*. No. 3—*ceratus;* local variants a (St. Ann's Bay) and b (Ferry) are probably derived from the Clydesdale pattern of single flashes repeated indefinitely at ½ to 1 second intervals; variant c seen at high altitudes, 4300 to 5000 ft. No. 4—*commissus;* shorter interval in summer observations. No. 5—*elisabethae*. No. 6—*euphotus*. No. 7—*evanescens;* twinkle sometimes so rapid as to look like a single flash or glow from a distance; number of intercalated flashlets quite variable both as to number and timing; twinkle shorter at western end of the Island, e.g., Montego Bay, than in the east, e.g., John Crow Mountains. Several specimens were seen in winter giving a long series of 20 or more very short and rapid flashes (variant b). No. 8—*flavolimbatus;* often grouped in units of 5 to 7; very similar to *variabilis*. No. 9—*gracilobus*. No. 10—*harveyi*. No.11—*jamaicensis;* occasional "singles" reported are perhaps twinkles so rapid as to blur. No. 12—*leucopyge;* sometimes grouped; some indication that individual flashes are compound. No. 13—*lewisi;* possibly a high-frequency flicker. No. 14—*lobatus;* lowland type of flash is figured; the Blue Mountains form gives a rapid twinkle. No. 15—*lundi*. No. 16—*melanurus;* usually in groups of 5 to 11 flashes, then a lapse of 3 or 4 seconds. No. 17—*morbosus;* occasionally with dim intercalated flashlets. No. 18—*naevus;* some records suggest a vibratory flash or twinkle. No. 19—*nothus;* resembles No. 7, but no intercalated flashlets; two records of double flashes like *harveyi*. No. 20—*pallens;* the Blue Mountains form is diagrammed; lowland variants include two- to four-peaked intensity fluctuations during flash, and shorter single flashes. No. 21—*synchronans;* some records suggest a vibratory flash. No. 22—*variabilis;* both single flashes and groups, variable in timing. No. 23—*xanthophotis;* lowland form gives main flash about every 6 secs., with intercalated flashlets; *xanthophotis catherinae* gives sharp single flashes about 1.5 secs. apart, with no flashlets.

VII. Notes on Life History, Habits, Larvae, etc.

At the present time no definite life history studies on Jamaican Lampyridae comparable to those of Williams (1917) and Hess (1920) on North American species have been made. There is little doubt, however, that in general the course of events is similar to that of the American species, except that under tropical conditions the life cycle may be shorter than in a temperate climate. Larvae of two unknown species have been found feeding on snails and as the latter are very plentiful and varied in Jamaica they are probably the favorite prey. No evidence has been reported that the adults take food, but the complete structure of the mouth seems to indicate that they may do so, as has been found for North American species. One of the authors (McD) failed to find cannabalism among living specimens of *Photuris jamaicensis,* as had been noted with *P. versicolor* (Barber, 1951), or *Photinus pallens.* As noted in the section on flashing conduct and mating signal systems, actual mating in any species was not observed by either of us in Jamaica.

While the majority of the species of *Photinus* and *Diphotus* collected in Jamaica are at least crepuscular, and frequently fly all night (e.g., *Photinus pallens* and *P. synchronans*), it is of interest that *Diphotus montanus* was collected in the day time on *Polygonum chinense,* probably feeding on aphids or other insects on the plants. *D. flavomarginatus* was taken in flight at 3:30 PM on July 13, and *D. pantoni* has also been taken in the daytime. *Photinus pallens, P. evanescens,* and *P. evanescens* var. *dubius,* were simultaneously in flight in the early evening, just after sundown in February, and at least *evanescens* in addition to *pallens* continued to fly for some hours. *P. commissus* usually appeared during the brief twilight in January and February, and *P. synchronans* a little later. The remarkable phenomena of synchronous flashing (*P. synchronans*), assembling (*P. pallens*), and also more extensive data on the time of flight have already been referred to in the preceding section.

Although we have no statistical evidence to present, one of us (McD) has the impression from the collections he has seen that

specimens collected in the winter months tend to average slightly smaller than those collected in summer, though there are individual cases of the reverse.

Photinus pallens and *P. synchronans* both produce a blue fluorescence in alcohol, as does *P. pyralis,* and *synchronans* has an odor much like that of the latter species.

Lampyrid larvae, popularly called glow-worms although this term may include apterous females, have curiously been but rarely found or reported in Jamaica in spite of the fact that they must be present literally in millions. Those that have been collected cannot usually be assigned to a known species. In the collection of the Institute of Jamaica is one large brown glow-worm which is, with very little question, the full-grown larva of *Jamphotus tuberculatus,* agreeing with Barber's description of the adult female (the male is unknown) except in the absence of rudimentary elytra and the presence of a brush of filaments at the posterior end. This was found at Portland Gap, St. Thomas Parish, by T. Dale, on October 14, 1950, under bark, at an altitude of 5,600 ft., thus agreeing with the altitude at which the adults had been taken. Another specimen in this collection which may be assigned to a known species was found by Mr. G. R. Proctor in decaying wood at Heron Hill, Manchester Parish, altitude 2,100 ft., on March 10, 1952. It is very large, 32 mm. long by 6.5 mm. broad, black dorsally and mainly so ventrally, but the ventral abdominal segments bear a definite pattern in yellow. This can hardly be other than the larva of *Photinus xanthophotis* (Gosse). A smaller, light brown, glow-worm was found in rich humus under a decaying log at Abbey Green, St. Thomas Parish, altitude 4,300 ft., on December 16, 1951, by Mr. Proctor. This appears to be a *Photinus* larva and at this altitude might be *P. alticola* but cannot be definitely assigned. A small, brown, narrow glow-worm with a pale yellow prothoracic segment and a peculiar pale dorsal marking above the luminous organs, which appeared to occupy portions of both the 7th and 8th segments, was collected by G. B. Thompson under a log at Hardwar Gap, altitude 4,000 ft., on December 5, 1946. The peculiar appearance of this larva, differing from those of known *Photinus,* suggests that it may be a species of *Diphotus,* or possibly an apterous

female. Three small, dark brown larvae found in garden soil in St. Andrew Parish, differ from the usual *Photinus* type in that the mandibles, instead of being small and projecting from a small and retractable head, are large and open widely, and each is provided with an inwardly projecting prong at about midlength. On February 21–24, 1952, a series of small dorsally grey glow-worms was found on spray-drenched rocks at Whitehouse Bay (McDermot, 1953). In view of the resemblance of these larvae to those of North American species of *Lecontea,* and the subsequent finding of *L. gamma* at this station by Dr. T. H. Farr, these may be the larvae of the latter species.

The larva of the North American species of *Photuris* are quite characteristic—broad, flat-backed, the dorsal segments lobed. It would be assumed that the larvae of *P. jamaicensis* would be similar but no glow-worms of this type are in the collection of the Institute of Jamaica or have been reported as found. Nor have any larvae definitely referable to the commoner species such as *Photinus pallens, P. synchronans, P. evanescens, P. commissus,* etc., been identified. The absence of any considerable number of collections of larvae assignable to *Photinus* is partially explicable by the fact that these appear to be burrowers. The same is probably true of the larvae of *Diphotus,* but those of the North American species of *Photuris* normally crawl on or near the surface, in leaf litter, and are easily found by their glows. This would be expected to be the case with *Photuris jamaicensis.*

Dr. Buck took a number of lampyrid larvae during his visits in 1936 and 1941 but they cannot be assigned to known species. In 1951–52, McDermott made a special point of investigating known habitats for larval lampyrids—decaying wood, stumps, under bark and logs, stones, litter, etc.—but except for those at Whitehouse Bay was entirely unsuccessful. Mr. Proctor is evidently a better glow-worm collector!

It is disappointing that we are able to record so little information on this interesting phase of lampyrid life. It would seem that a continuous study over at least one year, probably two, would be required to obtain the required information for some of the commoner species.

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Explanation of Figures

In the aedeagal drawings for each species, A is the dorsal view, B the lateral, and C the ventral. The scale line in each aedeagal drawing equals ½ mm. Magnifications for the habitus photographs are all between 4× and 5× actual size.

Plate I—Habitus of Species

Fig. 1.—*Microdiphot cavernarum.*
Fig. 2.—*Microdiphot barberi.*
Fig. 3.—*Photinus harveyi.*
Fig. 4.—*Photinus nothoides.*
Fig. 5.—*Photinus leucopyge.*
Fig. 6.—*Photinus chapini.*
Fig. 7.—*Diphotus farri.*
Fig. 8.—*Photinus nothus.*
Fig. 9.—*Photinus evanescens.*
Fig. 10.—*Photinus alticola.*
Fig. 11.—*Photinus commissus.*
Fig. 12.—*Diphotus caputdelphini.*
Fig. 13.—*Diphotus dahlgreni.*
Fig. 14.—*Diphotus unicus.*
Fig. 15.—*Photinus pardalis.*
Fig. 16.—*Photinus lewisi.*
Fig. 17.—*Photinus lundi.*
Fig. 18.—*Diphotus darlingtoni.*
Fig. 19.—*Photinus gracilobus.*
Fig. 20.—*Photinus morbosus.*
Fig. 21.—*Diphotus flavomarginatus.*
Fig. 22.—*Diphotus masti.*
Fig. 23.—*Photinus flavolimbatus.*
Fig. 24.—*Diphotus lucivolans.*
Fig. 25.—*Photinus evanescens* var. *dubius.*
Fig. 26.—*Presbyolampis immigrans.*
Fig. 27.—*Photinus ceratus.*
Fig. 28.—*Photinus elisabethae.*
Fig. 29.—*Diphotus pantoni.*

Plate II—Habitus of Species

Fig. 30.—*Lecontea gamma.*
Fig. 31.—*Photinus naevus.*
Fig. 32.—*Photinus blackwelderi.*
Fig. 33.—*Diphotus montanus.*
Fig. 34.—*Photinus synchronans.*
Fig. 35.—*Photinus lobatus.*
Fig. 36.—*Photinus variabilis.*
Fig. 37.—*Photinus melanurus.*
Fig. 38.—*Photuris jamaicensis.*
Fig. 39.—*Diphotus bucki.*
Fig. 40.—*Diphotus semifuscus.*
Fig. 41.—*Diphotus glaucus.*
Fig. 42.—*Photinus lucernula.*
Fig. 43.—*Diphotus ornicollis.*
Fig. 44.—*Photinus hypoleucus.*

Plate III—Habitus of Species

Fig. 45.—*Photinus amplus.*
Fig. 46.—*Photinus brunescens.*
Fig. 47.—*Jamphotus tuberculatus.*
Fig. 48.—*Photinus pallens.*
Fig. 49.—*Photinus xanthophotis.*
Fig. 50.—*Photinus euphotus.*

Plate IV—Aedeagi

Fig. 51.—*Diphotus pantoni.*
Fig. 52.—*Diphotus masti.*
Fig. 53.—*Diphotus semifuscus.*
Fig. 54.—*Diphotus unicus.*
Fig. 55.—*Diphotus dahlgreni.*
Fig. 56.—*Diphotus ornicollis.*

PLATE V—AEDEAGI

Fig. 57.—*Diphotus darlingtoni.*
Fig. 58.—*Diphotus bucki.*
Fig. 59.—*Microdiphot barberi.*
Fig. 60.—*Microdiphot cavernarum.*
Fig. 61.—*Diphotus montanus.*
Fig. 62.—*Diphotus glaucus.*

PLATE VI—AEDEAGI

Fig. 63.—*Presbyolampis immigrans.*
Fig. 64.—*Photuris jamaicensis.*
Fig. 65.—*Photinus pallens.*
Fig. 66.—*Lecontea gamma.*
Fig. 67.—*Diphotus flavomarginatus.*

PLATE VII—AEDEAGI

Fig. 68.—*Photinus blackwelderi.*
Fig. 69.—*Photinus harveyi.*
Fig. 70.—*Photinus alticola.*
Fig. 71.—*Photinus nothoides.*
Fig. 72.—*Photinus synchronans.*

PLATE VIII—AEDEAGI

Fig. 73.—*Photinus brunescens.*
Fig. 74.—*Photinus naevus.*
Fig. 75.—*Photinus melanurus.*
Fig. 76.—*Photinus lundi.*
Fig. 77.—*Photinus variabilis.*

PLATE IX—AEDEAGI

Fig. 78.—*Photinus hypoleucus.*
Fig. 79.—*Photinus evanescens.*
Fig. 80.—*Photinus amplus.*
Fig. 81.—*Photinus amplus,* var.
Fig. 82.—*Photinus xanthophotis.*

PLATE X—AEDEAGI

Fig. 83.—*Photinus pardalis.*
Fig. 84.—*Photinus lobatus.*
Fig. 85.—*Photinus lewisi.*
Fig. 86.—*Photinus ceratus.*
Fig. 87.—*Photinus morbosus.*

PLATE XI—AEDEAGI

(The scale line for fig. 88, accidentally omitted, should be 24 mm.)

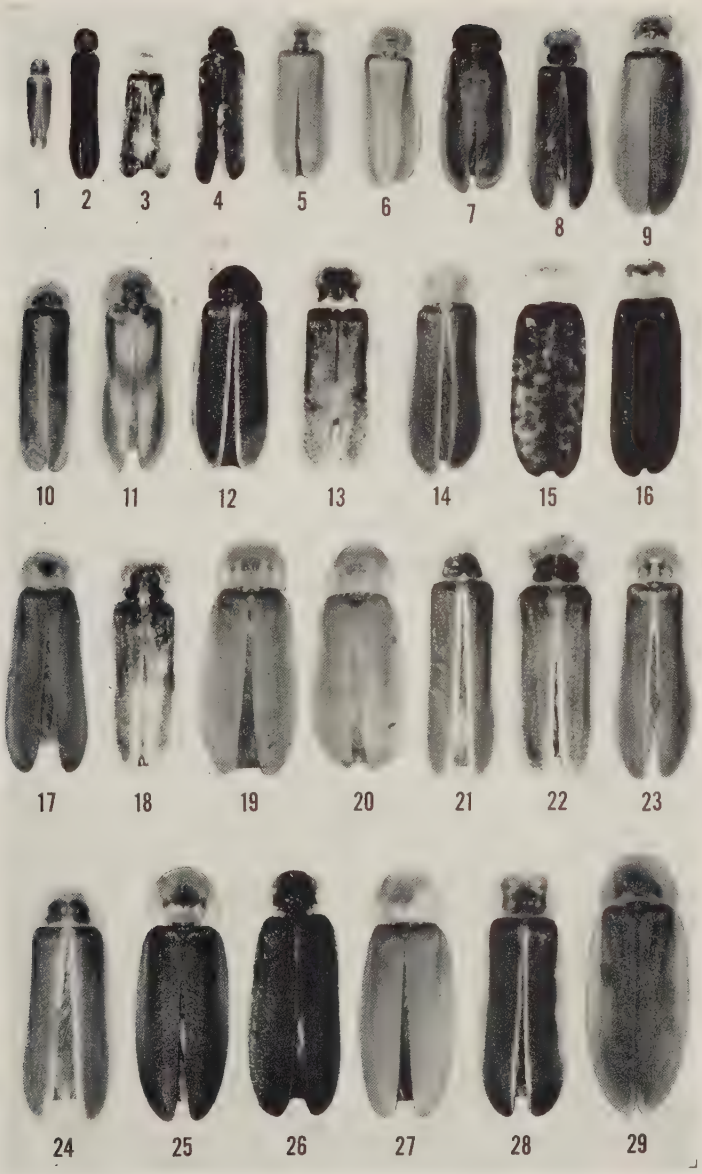
Fig. 88.—*Photinus elisabethae.*
Fig. 89.—*Photinus leucopyge.*
Fig. 90.—*Photinus chapini.*
Fig. 91.—*Photinus nothus.*
Fig. 92.—*Photinus flavolimbatus.*

PLATE XII—AEDEAGI

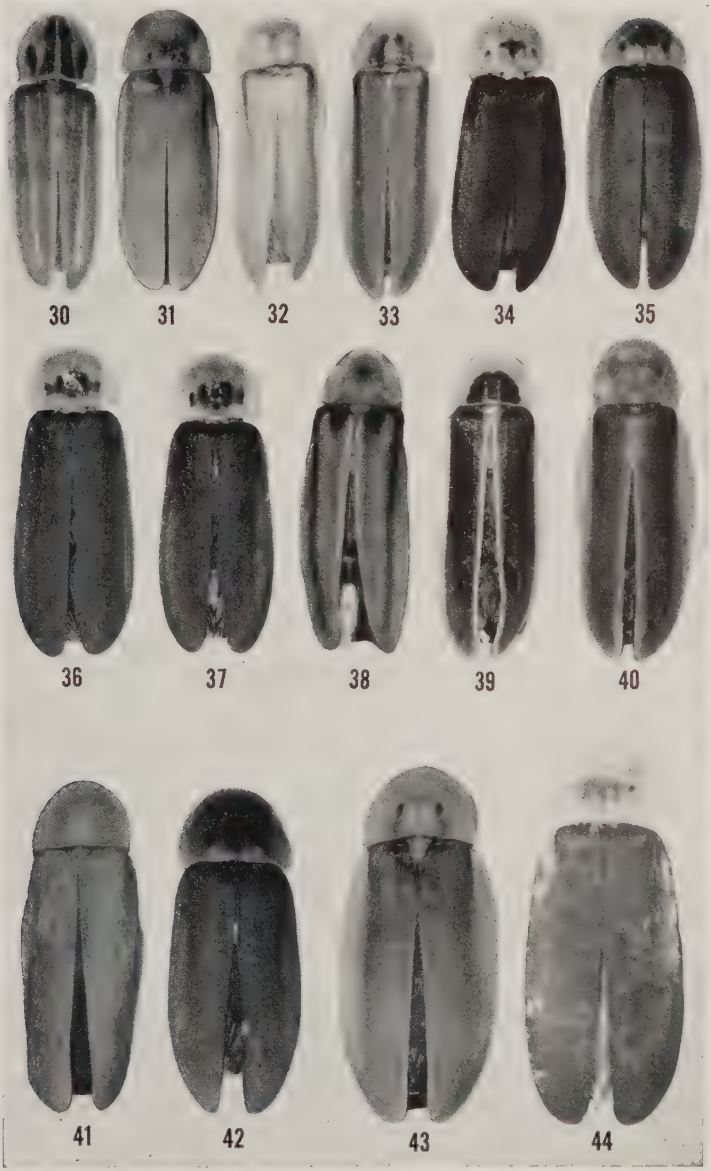
Fig. 93.—*Diphotus farri.*
Fig. 94.—*Photinus gracilobus.*
Fig. 95.—*Diphotus caputdelphini.*
Fig. 96.—*Photinus euphotus.*
Fig. 97.—*Photinus lucernula.*

PLATE XIII—AEDEAGI

Fig. 98.—*Photinus commissus* i.
Fig. 99.—*Photinus commissus* ii.
Fig. 100.—*Photinus commissus* iii.
Fig. 101.—*Photinus commissus* iv.



McDERMOTT AND BUCK: LAMPYRIDS OF JAMAICA



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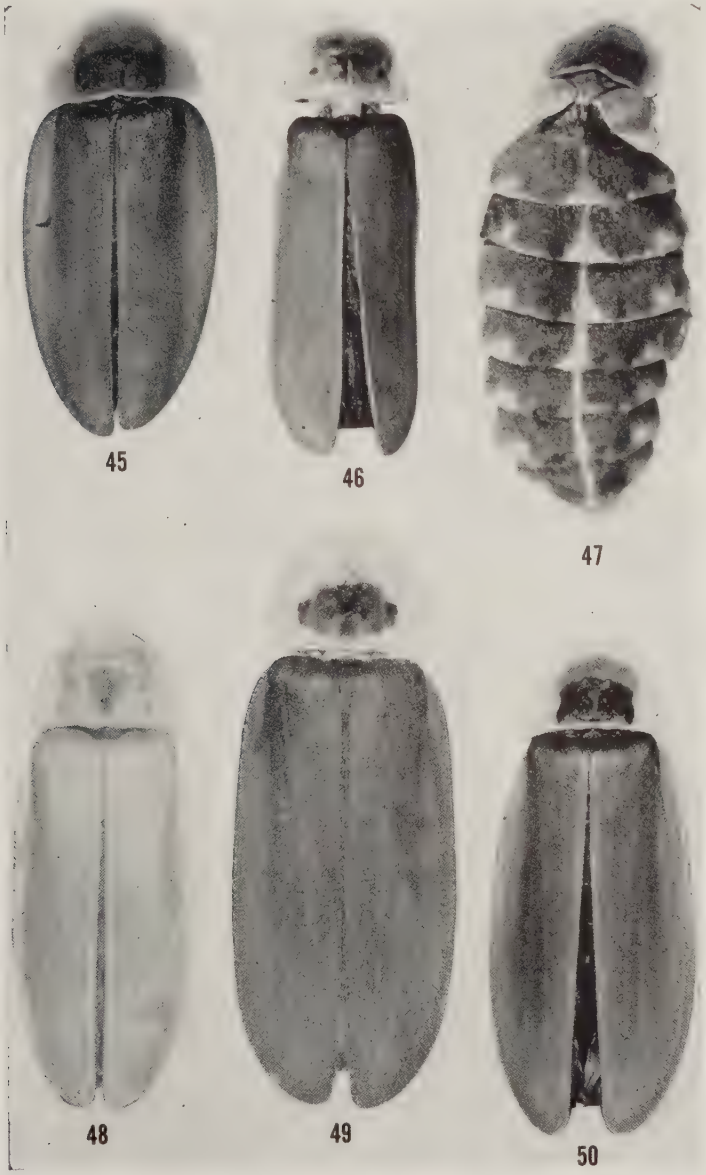

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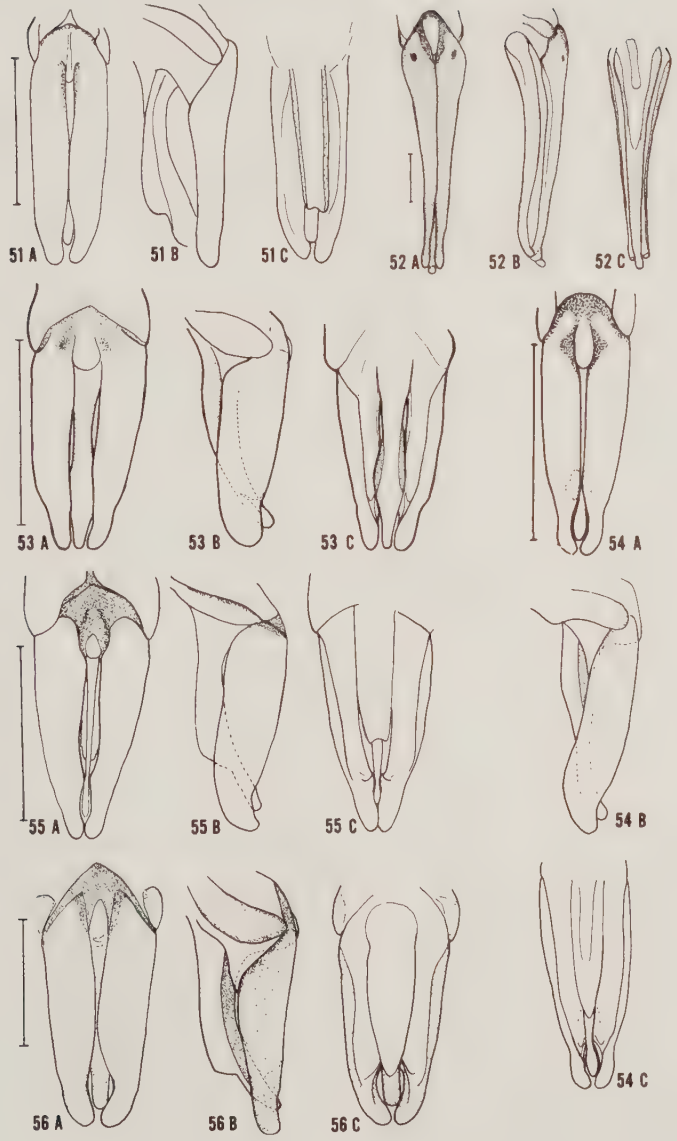

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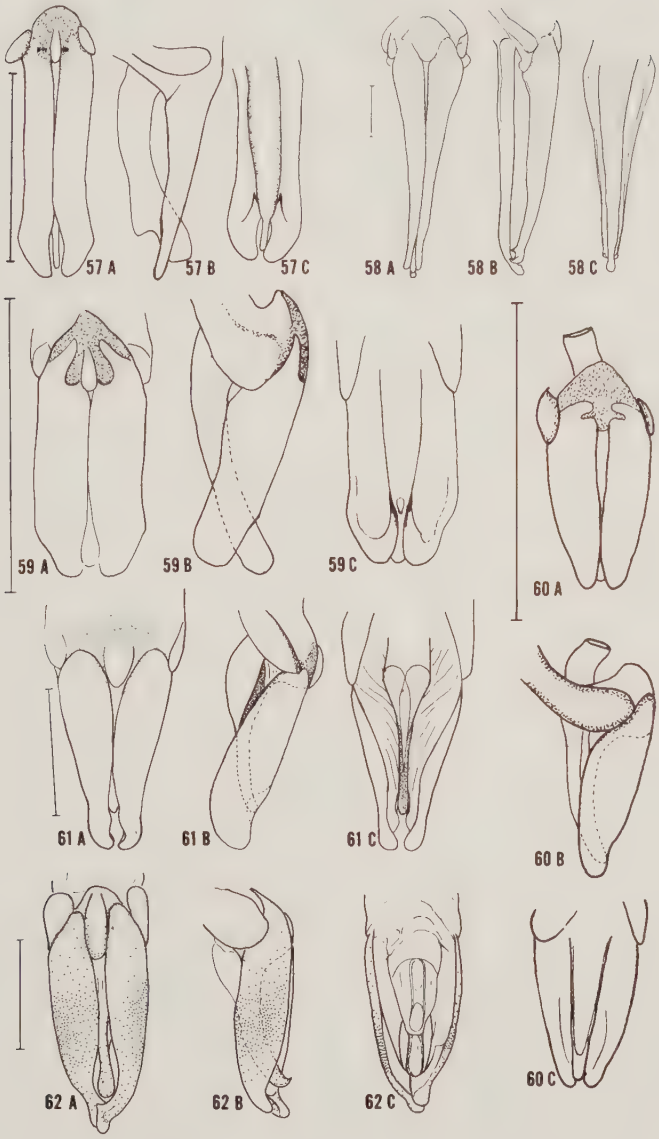

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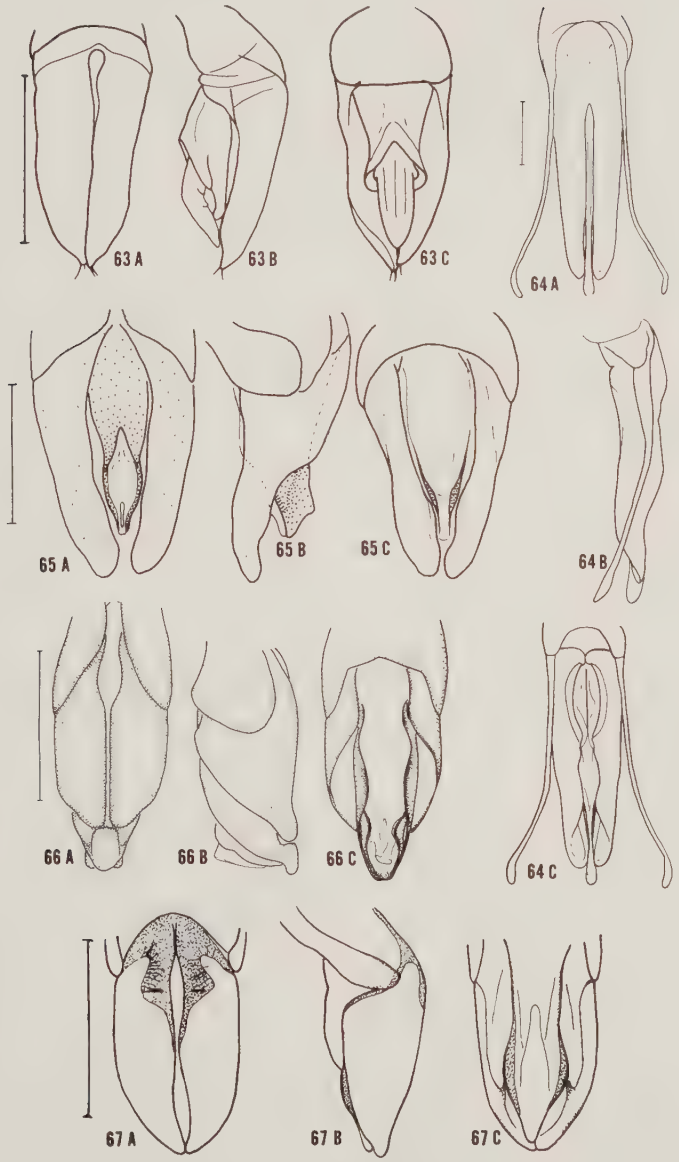

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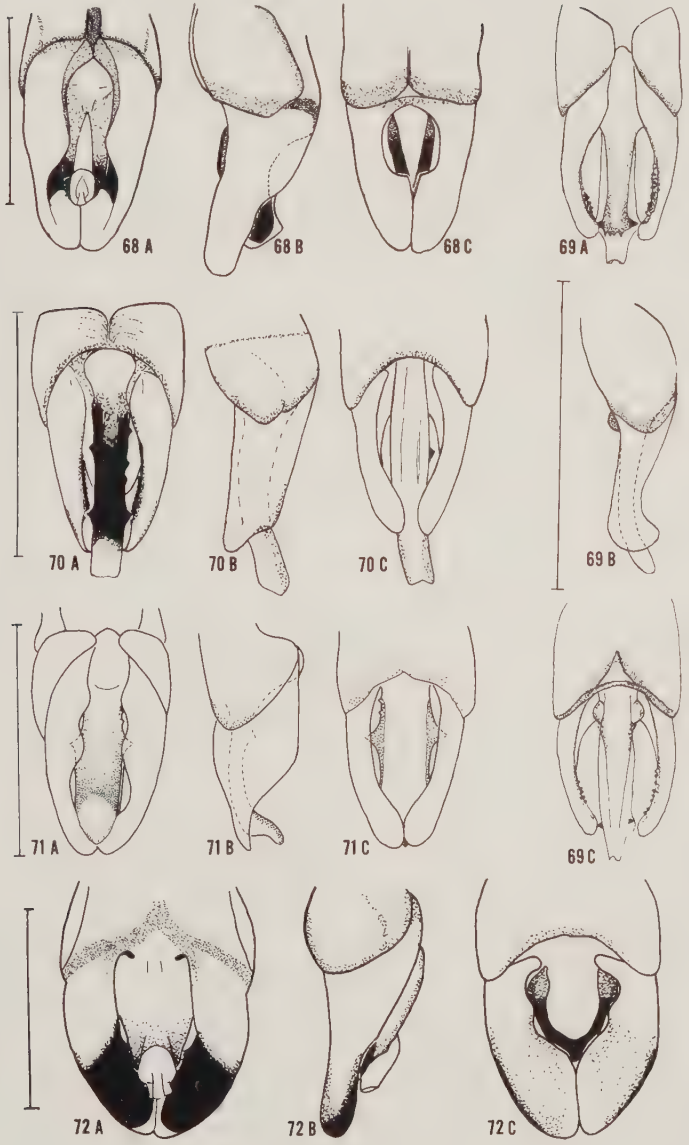

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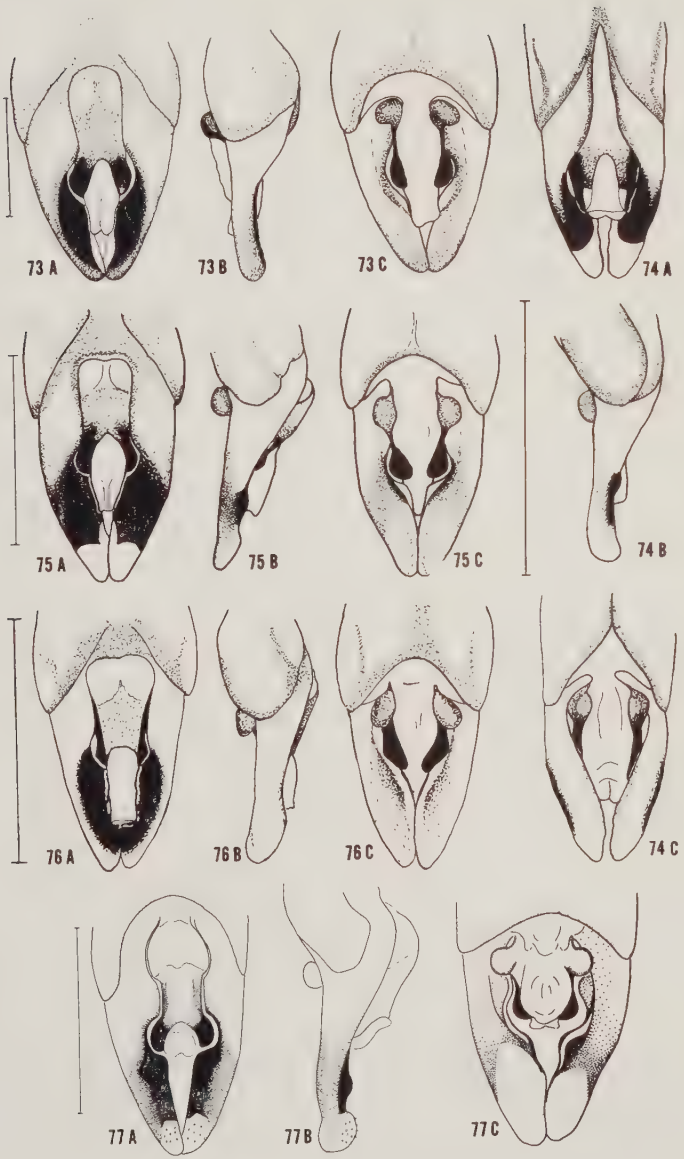

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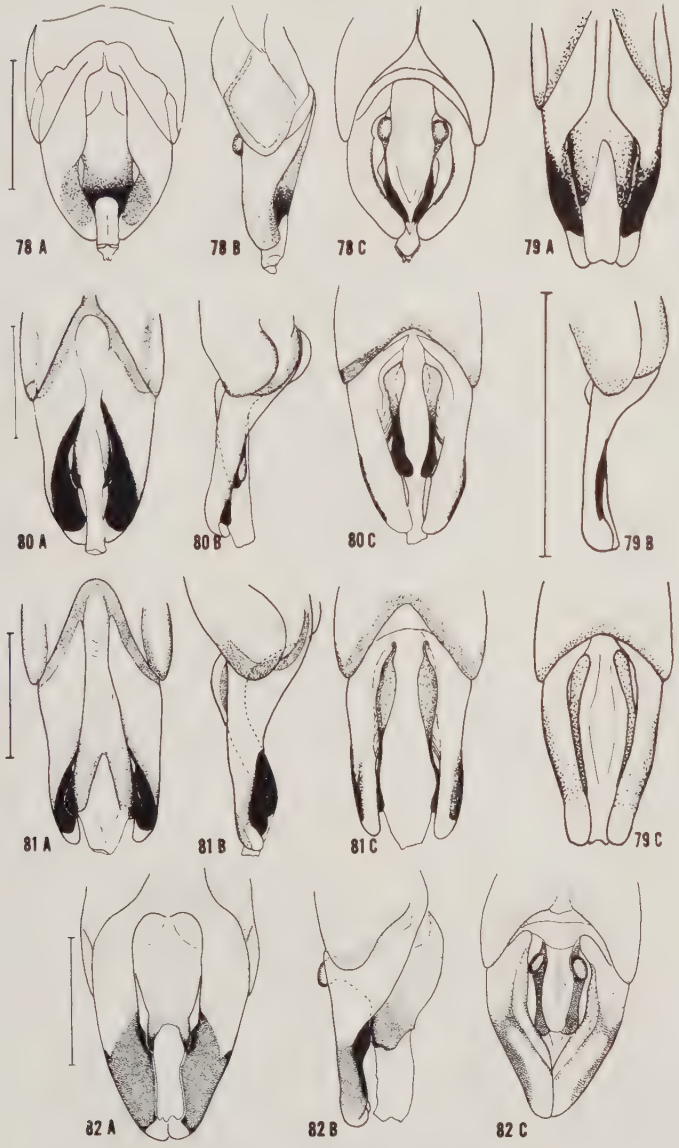

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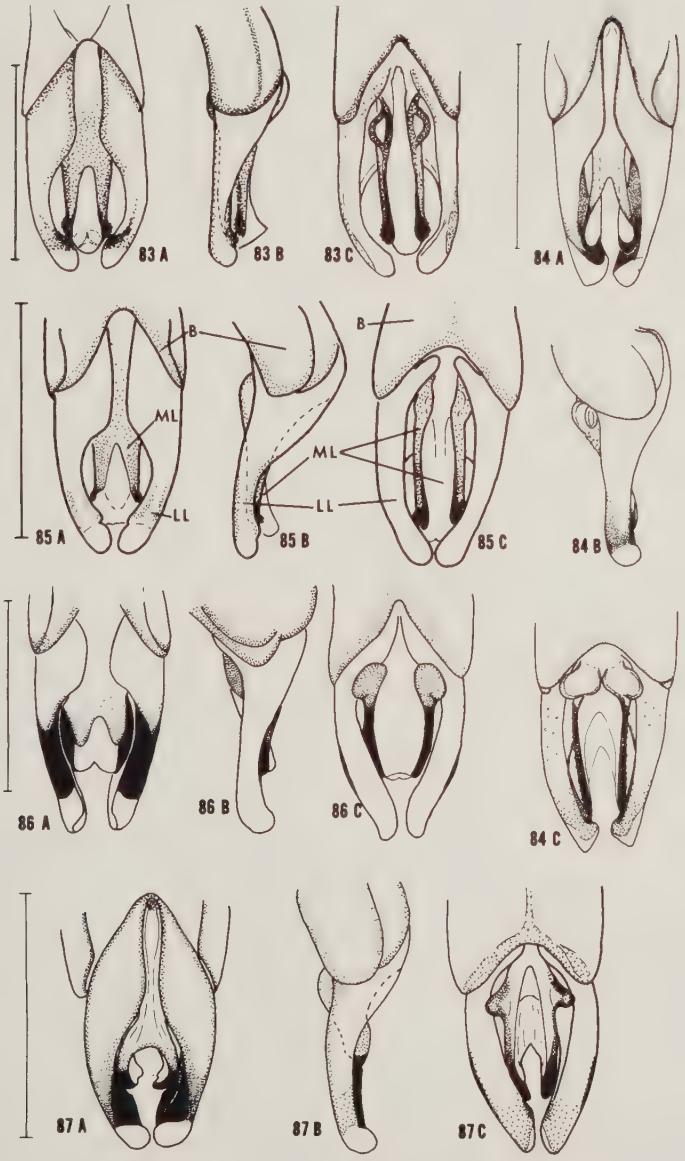

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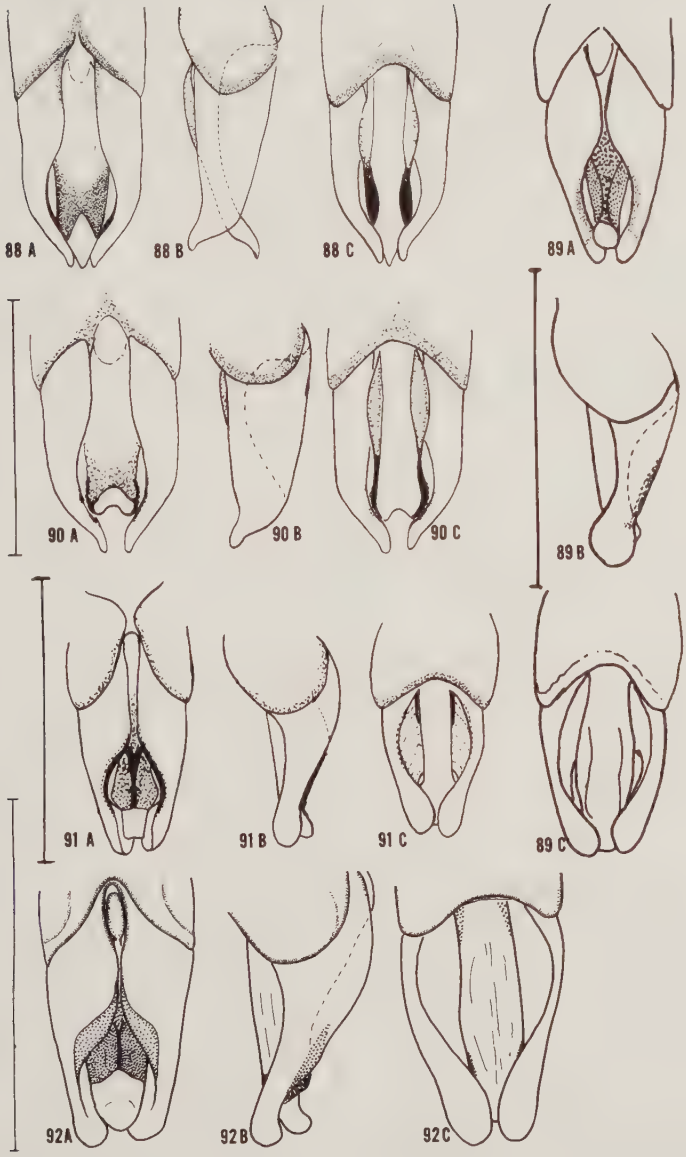

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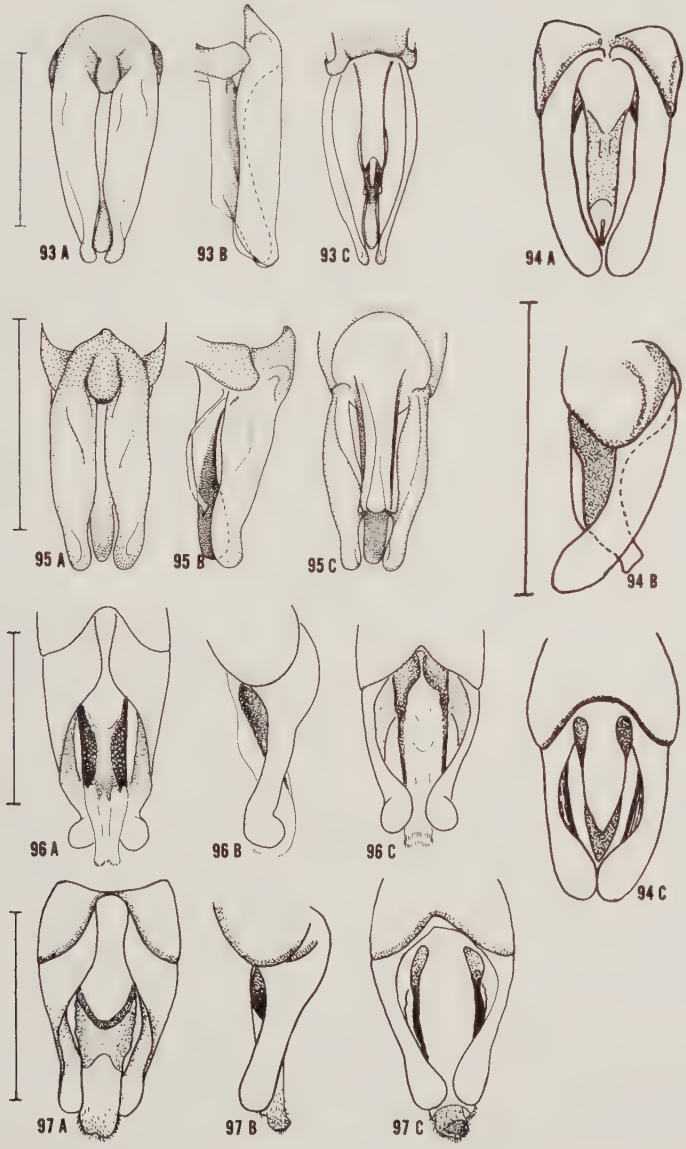

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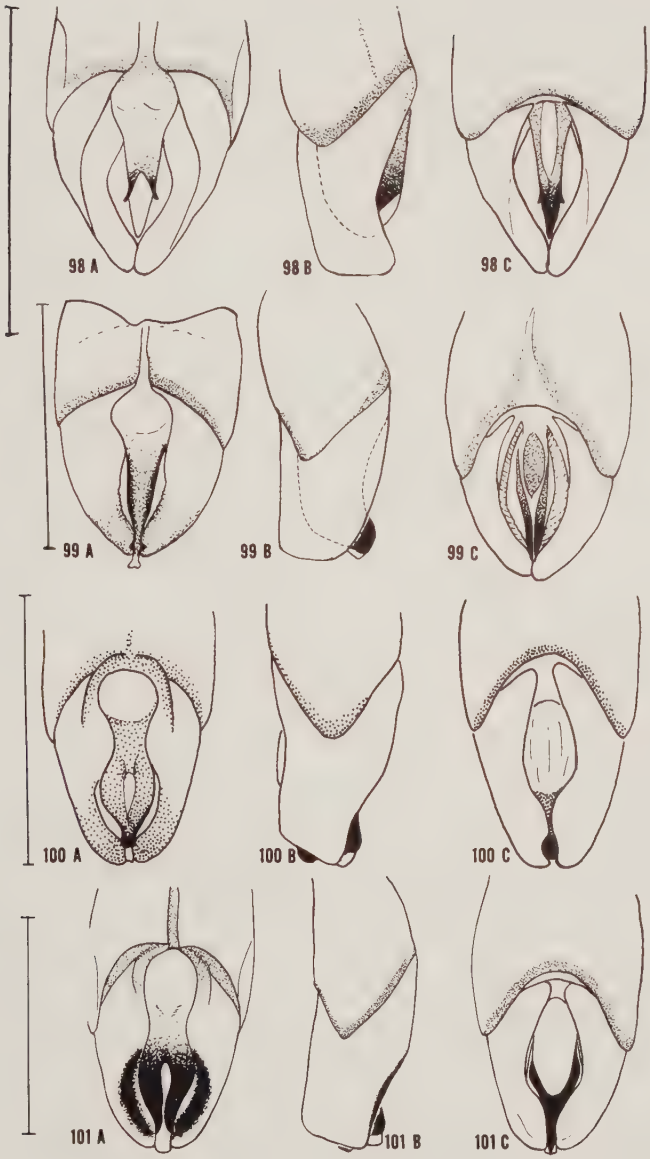

McDERMOTT AND BUCK: LAMPYRIDS OF JAMAICA

THE SUBGENUS ABLABESMYIA OF PENTANEURA (DIPTERA; TENDIPEDIDAE; PELOPIINAE)

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Introduction

The species treated herein comprise Group A of Edwards (1927) and Johannsen (1946). Freeman (1955) has, on the basis of the hypopygial structures and other characters, considered this group as a distinct subgenus. He uses the name *Ablabesmyia* (Johannsen 1905). An examination of most of the North American species has convinced me of the soundness of Dr. Freeman's conclusion. Further study may well show, as Freeman suggests, that *Ablabesmyia* merits full generic status.

I have seen all of the twelve species or varieties keyed by Johannsen (1946), except *P. prudens* (Walley) and *P. idei* (Walley), and I have been able to examine in detail the aedeagus of all but the above two species. *Pentaneura monilis* var. 1 and var. 2 of Johannsen are described as new species and two other new species are described.

I should like to gratefully acknowledge the following loans; specimens of the subgenus, including a paratype of *P. mallochi*, by Dr. Henry Dietrich of Cornell University; a series of specimens from the U. S. National Museum Collection, arranged by Dr. Willis W. Wirth to whom I am also indebted for the privilege of being able to examine the type of *P. cinctipes* and other material in the U. S. National Museum collection; a slide of the genitalia of a paratype and another specimen of *P. basalis* (Walley) by Dr. J. R. Vockeroth of the Canadian National Museum, two specimens determined as *P. basalis* by Walley were donated to the Academy's collection. I am, in addition, indebted to Drs. Hubert and Mabel Frings for the large series of specimens of a new species from Mt. Desert Island, Maine.

In the description the position of the mesal tibial ring of the foreleg is given by dividing distance W by X, as shown on figure 42 F; for the first tarsal segment by dividing Y by Z. The locations of the specimens examined are abbreviated as follows: Cornell University (C), U. S. National Museum (U.S.N.M.), Academy of Natural Sciences of Philadelphia (A.N.S.P.), Canadian National Museum (C.N.M.).

The Aedeagus

In the subgenus *Ablabesmyia,* the aedeagus offers the most reliable characters for the differentiation of the species and an understanding of their relationships. This is particularly true in the species of the *monilis* group in which the species in most cases cannot be reliably separated without reference to the aedeagal structures.

The aedeagal complex consists of four parts. These are: 1—the aedeagal blades (A); 2—the dorsal lobes (B); 3—the lateral lobes (C); 4—the lateral filaments (D). These are all present and illustrated in figs. 5 and 26. The measurements given in the table on page 116 are an average and there may be a variation of eight to ten percent in the aedeagal parts in either direction.

Aedeagal Blades (*A*).—These are the paired median sclerotized rods which lie on either side of the mid-line of the hypopygium (figs. 23 and 28). In all cases they are upcurved, to some degree, from the base. In natural or resting position they appear as straight rods (fig. 23) but when flattened out they appear claw-like (figs. 26 and 27). Quite a bit of variation in the apparent shape of the parts of the aedeagal complex can be introduced by the degree to which the hypopygium is flattened in mounting (figs. 23–26). Some caution must therefore be exercised in interpreting minor differences in the shape of the aedeagal blades and of the other parts of the aedeagal complex. In *P. monilis* and *P. basalis* the blades are sinuate in the vertical plane. After curving upward from the base, the apical section curves downward again (figs. 29–31). When flattened they appear as S-shaped structures (figs. 29–30). In many specimens of *P. monilis* the aedeagal complex is everted with the aedeagal

blades inverted and extending outwards (fig. 32). Some specimens of *P. annulata* show a tendency of the tips of the aedeagal blades to recurve (fig. 33).

Dorsal Lobes (*B*).—These lie above the aedeagal blades and are broadly attached to their bases. In natural position, dorsal view, they appear as tubular or triangular structures, generally with apical and subapical setae (figs. 17, 23, and 28). They are always shorter than the aedeagal blades. Only in *P. janta* and *P. johannseni* do the apical setae appear to be lacking. When flattened the dorsal lobes are seen to be broad compound structures (figs. 26 and 31). They consist of a clear narrow basal section which bears one to three broad spines apically and a distal globose lobe with many fine setae or filaments (fig. 26). In *P. aspera* the basal section is small and cannot be seen except in completely flattened mounts. In *P. monilis,* however, the basal section has become the dominant element of the dorsal lobes and the apical section, which sometimes appears to be a separate structure, is not easily seen in some mounts. The dorsal lobes of *P. basalis,* text figs. 2A and B, are somewhat intermediate between *P. aspera* and *P. monilis.* In *P. annulata* the parts of the dorsal lobes appear to have fused and cannot be separately distinguished (fig. 34).

Lateral Lobes (*C*).—The lateral lobes lie lateral of the aedeagal rods and are attached to the semi-membranous base of the lateral filaments. They appear to have arisen by the fusion of the lateral filaments closest to the aedeagal blades. The semi-membranous lateral lobes of *P. aspera* (figs. 5 and 26) appear to be so formed. In *P. janta, P. johannseni,* and *P. annulata* the lateral lobes are more highly sclerotized and enlarged (figs. 34–36) and in the former two species are longer than the aedeagal blades. In *P. monilis* and *P. basalis* the lateral lobes could not be seen but they are probably like those of *P. aspera.* Lateral lobes, as such, were not found in *P. mallochi, P. auriensis, P. gera,* and the members of the *illinoensis* group. Inasmuch as the membranous lateral lobes of the *monilis* group are not easily seen, except in mounts in which the parts are favorably oriented, the absence of lateral lobes in these species may be more apparent than real.

Comparison of Parts of Distyle and Aedeagus

	Length of blade	Length of dorsal lobe	Length of lateral lobe	Length of apex of distyle	Ratio of blade length to apex of distyle	Presence of bulge	Lateral filaments	Preapical stylet
peleensis	.041	.012	----	.039	1.05	-	L	P
illinoensis	.041	.014	----	.041	1.00	+	L	P
cinctipes	.050	.020	----	.031	1.61	-	L	P
mallochi	.043	.022	----	.034	1.26	±	L	E
auriensis	.043	.014	----	.034	1.26	-	L	E
aspera	.057	.038	.048	.036	1.60	+	L	E
gera	.072	.038	----	.048	1.50	±	L	E
janta	.050	.035	.069	.041	1.20	-	S	E
johannseni	.058	.036	.091	.036	1.61	-	S	E
monilis	.085	.036	----	.034	2.50	±	L	E
annulata	.12	.073	.087	.053	2.25	+	± L	E

L - Long S - Short P - Pointed E - Expanded. All measurements in mm.

Lateral Filaments (D).—These lie between the bases of the aedeagal rods and the inner corner of the basistyle (figs. 32, 35, and 36). Their base is semi-membranous and appears to connect with a protuberance at the inner corner of the basistyle. In most cases the filaments are moderately elongate (figs. 26 and 32) being as long as or only slightly shorter than the aedeagal blades. In *P. annulata* they are slightly reduced and in *P. johannseni* and *P. janta* they have been reduced to relatively short, curved, filaments (figs. 35, 36). As is mentioned above, those filaments closest to the aedeagal blades appear to have given rise to the lateral lobes.

Phylogeny

The subgenus *Ablabesmyia* is differentiated from the remainder of *Pentaneura* on the basis of the bare prescutellar area, the pre-apical spine of the distyle, the expanded apex of the distyle (fig. 11), and the aedeagal complex. With one exception, the larvae have one–three claws of the posterior prolegs dark. The character of the pupal respiratory organs would also support the separation of *Ablabesmyia* from the remainder of *Pentaneura.*

Any discussion of phylogeny within the subgenus must be based on comparative morphology only, since our knowledge of the geographical distribution of the species is so fragmentary as to be all but useless.

One comment might be made at this point. With fourteen species recorded from North America and eight or nine from Africa (Freeman 1955) it is highly unlikely there are only one or two rather specialized (*monilis* group) species in Europe.

The primary division within the subgenus is into the *illinoensis* group in which the pre-apical spur of the distyle has retained the simple apex (fig. 13) found in the remainder of *Pentaneura,* and the *monilis* group in which the spur has become curved and expanded apically (fig. 10).

The *illinoensis* group consists of the species *P. peleensis, P. illinoensis,* and *P. cinctipes.* Of these, *P. peleensis* on the basis of its narrow median foretibial band is the most primitive. This median band, and the other bands have widened in *P. illinoensis* (fig. 42b). The three median bands of *P. cinctipes* (fig. 42a) have probably arisen through a secondary division of the sub-

basal and the widened median foretibial bands. There are no striking differences in the aedeagi of the three species (figs. 38–41).

Three of the African species listed by Freeman (1955) fall in this group. With the exception of *P. melaleuca* (Goetghebuer), which on the basis of its genitalia, wing and leg markings appears to be close to *P. peleensis,* they are more specialized than any of the North American species. The aedeagal complex of *P. pictipes* (Kieffer) shows the same eversion of its parts as is found in *P. monilis* (fig. 32).

The most generalized members of the *monilis* group are *P. auriensis,* and *P. mallochi.* Here the aedeagal blades (figs. 17–22), are short (less than 1.4 × distyle apex) and the dorsal lobes separated and relatively simple. The aedeagi of these two species differ little from those of the *illinoensis* group.

P. gera and *P. aspera* present a more specialized form of aedeagus than the aforementioned three species. The blade is longer (1.5–1.6 × apex of distyle) the dorsal lobes are larger and more complex (figs. 5, 23–26, and 37, and the lateral lobes are present in membranous form (fig. 26). The two species probably rose from the same stock which gave rise to *P. mallochi,* and *P. auriensis.*

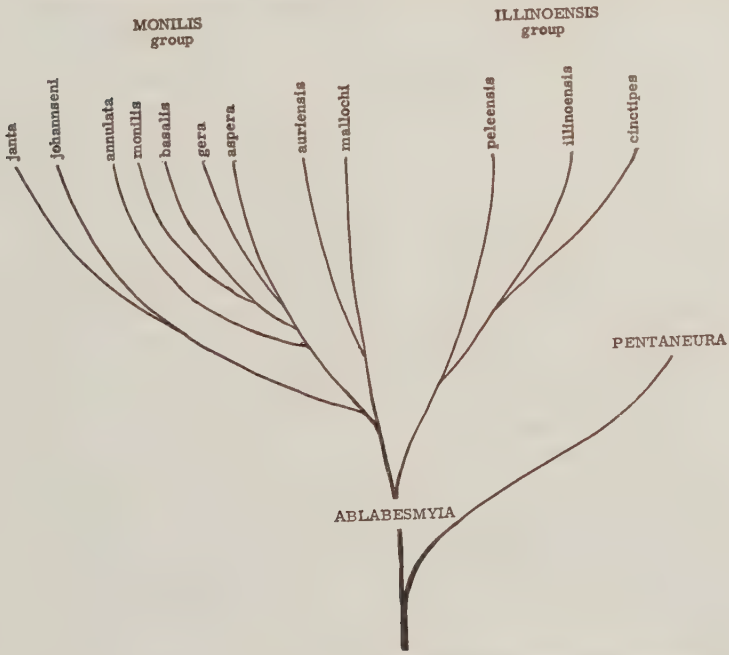
Although the lateral lobes of *P. basalis* and *P. monilis* could not be seen they are placed as a specialized offshoot of the *gera-aspera* line. The aedeagal blade of *P. basalis* is of the same length as *P. aspera* and the dorsal lobes of *P. aspera* and *P. basalis* are almost identical, fig. 26 and text-figs. 2A and B. The latter is more specialized in that the aedeagal blade has become sinuate and it seems to be intermediate between *P. aspera* and *P. monilis.* In *P. monilis* the aedeagal blade is longer and the dorsal lobe more complex. The eversion of the aedeagal blade is paralleled by that in the African *P. pictipes.*

Pentaneura annulata with its highly infuscated wing and subapically placed mesal band of the foretibia is one of the more specialized species of the *monilis* group. The formation of the aedeagal complex in resting position (fig. 33) shows its affinity to the *gera-aspera* and *monilis* lines. The lateral lobe of fig. 34, though larger and more sclerotized, is very much like

that of *P. aspera*. The long aedeagal blade with its tendency of the apex to recurve like that of *P. monilis*, the specialized dorsal lobe with its long hairs and lack of any clear division, seem to indicate that it, like *P. monilis*, is a specialized offshoot of the *gera-aspera* line and probably arose close to *P. monilis*.

In *P. johannseni* and *P. janta* the lateral lobe is large and sclerotized. On this basis, they probably arose from the *gera-aspera* line. However, the relatively short, simple aedeagal blades and relatively simple dorsal lobes would indicate that they arose very early on this line. The lateral lobes of both are longer than the aedeagal blades. The placement of this line in text-fig. 1 is also based on the apparent lack of lateral lobes in the *mallochi* line. If that line should prove to have a membranous lateral lobe, then the *johannseni-janta* line could have arisen from the same point as the *gera-aspera* line.

The aforementioned relationships are illustrated in text-fig. 1.



Text-figure 1.—The relationship of species of the subgenus *Ablabesmyia*.

Systematic

Key to Species[1]

1. Fore tarsi bearded ..... *prudens* (Walley)
   Fore tarsi with short hairs only 2
2. Foretibia with 3 median bands (fig. 42 a); femora with 2 sub-basal bands; preapical stylet of distyle acute ..... *cinctipes* Johannsen
   Foretibia with one median band (fig. 42 b–f); femora not as above .. 3
3. Median band near apical fourth (fig. 42 c); aedeagus as in figs. 33 and 34; wing heavily infuscated ..... *annulata* (Say)
   Median band near center; aedeagus not as above 4
4. Foretibial bands as wide as intervening white spaces (fig. 42 b); wing with four spots behind Cu_2; first tarsal segment of foreleg about as long or longer than second and third combined; preapical stylet of distyle acute ..... *illinoensis* (Malloch)
   Bands not as above, narrower 5
5. Lateral lobes of aedeagus longer than aedeagal blades (figs. 35 and 36); aedeagal blades less than .060 mm. long; lateral filaments short and curled 6
   Lateral lobes, if present, shorter than aedeagal blades, generally membranous (figs. 5 and 26); lateral filaments elongate (figs. 5 and 26) ... 7
6. Lateral lobe ending in brush (fig. 35) ..... *janta* n. sp.
   Lateral lobe broad, elongate with serrate edges (fig. 36)
   johannseni n. sp.
7. Aedeagal blade sinuate, less than .065 mm. long; up to 1.85 times as long as apex of distyle; spot at top of R_3 (text-fig. 2 C) distinct, covering costa ..... *basalis* (Walley)
   Aedeagal blade generally not sinuate; if so over .075 mm. long and over 2.1 times as long as apex of distyle; spot, if present, faint, seldom covering costa 8
8. Abdominal tergites 1–5 with sub-basal transverse brown fasciae (fig. 45), wing similar to fig. 1 ..... *auriensis* Roback
   Abdomen not as above 9
9. Wing as in fig. 16; spot in cell M basad of that below R_{2+3}; preapical spur of distyle acute; abdominal tergites 1–3 generally white
   peleensis (Walley)
   Wing not as above 10
10. Aedeagus as in figs. 28–31; blade over twice as long as apex of distyle; aedeagus may be everted (fig. 32) and project upward as in fig. 12
   monilis (L.)
   Aedeagus not as above, shorter; does not project 11

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[1] *P. idei* could not be definitely placed and is omitted from this key.

11. Blade of aedeagus over .050 mm., relatively heavy (figs. 23, 26, and 37), dorsal lobes .38 mm. long, complex and mesally approximated in resting position (fig. 23) 12

Blade of aedeagus less than .050 mm. (figs. 17–21); wing maculation as in fig. 1; dorsal lobes about .022 mm. long; relatively simple
mallochi (Walley)

12. Blade of aedeagus .072 mm. long; twice as long as dorsal lobe (fig. 37)
gera n. sp.

Blade of aedeagus. 055 mm. long; 1.5 times as long as dorsal lobe (fig. 23)
aspera n. sp.

illinoensis Group

Pentaneura (Ablabesmyia) illinoensis (Malloch)

1915. *Tanypus illinoensis.* Ill. State Lab. Nat. Hist. Bull., 10: 376.

This species, along with *P. peleensis* and *P. cinctipes*, differs from others of this subgenus in the straight and acute articulated stylet of the distyle.

Body length 4.2–5.0 mm.; head and antenna brown; antennal ratio about 2.33; thorax, postnotum and scutellum red brown to dark brown; vittae not too distinct; mesonotum with grey-green pollen, vittae less pollinose than surrounding areas; 7–9 hairs present anterior to the lateral vittae; wing 2.4–3.8 mm.; wing marked as in Walley 1928 (fig. 2); a spot may be present at the tip of M and the subbasal spot in cell Cu_1 is often very faint; halters red brown to brown; squamae fully fringed; leg ratio about .77; median tibial band position about .5 between sub-basal and apical bands; as wide as white areas on either side (fig. 42b); femora with a preapical brown ring; white areas on femora and tibia may have red-brown tinge; basal two-thirds of femora with strong red-brown infuscation; T1 slightly shorter than or equal to T2+T3 in specimens from the White Mountains and Washington, D. C. and Springfield, Mass., and barely longer in a specimen from Wambay, S. D., abdomen with tergites 1–2 or 1–5 light brown infuscated; tergites 3–8 or 5–8 dark black brown; the caudo-lateral area of tergites 1–5 lighter; basistyle dark brown, no basal swelling; apex of distyle (fig. 13) .04 mm. long; blade of aedeagus .04 mm. long; dorsal lobe of aedeagus .014 mm. long with 7–8 apical hairs (figs. 38 and 39).

Material examined:

1 ♂; Washington, D. C.; August 21; H. G. Dyar Coll.; (U.S.N.M.). 1 ♂; Washington, D. C.; (U.S.N.M.). 1 ♂; Springfield, Mass.; July 18, 1903; F. Knab.; (U.S.N.M.). 1 ♂; White Mountains; Morrison; (U.S.N.M.). 1 ♂; Wambay, S. D.; June 6, 1918; J. M. Aldrich; (U.S.N.M.).

Pentaneura (Ablabesmyia) peleensis (Walley)

1926. *Tanypus peleensis.* Can. Ent. 58: 64.

Four specimens of this species were found in a series labelled *P. monilis.* They demonstrate some variation in abdominal maculation from that described for the type and from the specimen reared by the author (1957), and offer an opportunity to provide a more complete description of the species.

Male.—Length 3.1–3.8 mm.; head, antennal scape, mesonotum and postnotum dark brown; antennal ratio 2.2; antennae light brown; mesonotal pollen green-gold with a whitish cast; a pair of bare spots are present laterally at the middle of each section of the median vittae and at the caudal end of each lateral vitta; 10+ hairs anterior to lateral vittae; scutellum lighter brown; leg ratio .8; position of median band of foretibia .5; basal half of fore femora dark; tibia of foreleg shorter than T1+T2; leg markings very sharp black-brown against white; wing 2.5–2.8 mm., marked as in fig. 16; abdomen with segments 1–3 clear or as in fig. 44; tergites 2–5 with a median longitudinal band with a darker area in the band one-third the distance from the base of each tergite (see fig. 44); apex of distyle .039 mm.; length of blade .041 mm.; dorsal lobe .012 mm. with 10+ hairs; outer margin of basistyle rounded with, at the most, only a slight bulge at the base (fig. 49).

Material examined:

1 ♂; Ithaca, N. Y.; (C). 3 ♂♂; Rancocas Pk., N. J.; June 5, 1924; R. C. Hallock; (C). 1 ♂; emerged June 17, 1953; Jct. alternate 23 and Route 320, near Gulph Mills, Pa.; S. S. Roback; (A.N.S.P.).

monilis Group

Pentaneura (Ablabesmyia) mallochi (Walley)

1925. *Tanypus mallochi.* Can. Ent., 57: 273.
1957. *Pentaneura monilis* var. Roback. Acad. Nat. Sci. Phila. Monograph, 9: 39.

This is a widespread and apparently very variable species. An examination of the aedeagi and the external markings of specimens from N. Y. to California does not show any differences upon which a division can be made. Some of the variation in the aedeagus is shown in figs. 17–21. The abdomen varies from a condition similar to that in fig. 2 to darker than fig. 46. Specimens from Georgia tend to be smaller and darker than the New York material but there is insufficient material available to permit any subspecific breakdown. The size range of

the Georgia specimens is from 2.5–3.1 mm., wing length 2.1–2.4 mm. The New York specimens range from 3.0–3.6 mm., wing length 2.2–2.7 mm. The following description is based on N. Y. material. Many of the specimens had been determined as *P. mallochi* var. by Johannsen.

Male.—Length 3.2 mm., antennal ratio 1.85; apical segment .096 mm. long; mesonotum brown; vittae slightly darker, not too distinct; median vittae divided; arrangement of hairs as in *P. aspera,* thorax brown with gold-green pollen; scutellum not lighter than mesonotum; postnotum dark brown; leg ratio .79; segments of foreleg starting with tibia in ratio 95 : 49 : 36 : 22 : 12; position of mesal rings of foretibia and metatibia .58 and .53 respectively; position of mesal first tarsal rings of foreleg and metathoracic leg .37 and .38 respectively; spur of foretibia .053 mm. long (fig. 13); wing 2.6 mm. long; marked as in fig. 1; spots below R_{2+3}, above apex of Cu_1 and at apex of M appear to run together; squamae fringed; halteres white; abdominal tergites 1–5 with light infuscation; paired longitudinal darker streaks faintly present (fig. 46); infuscation darker on tergite 5; tergites 6–8 dark brown, similar to *P. aspera;* abdomen overlain by gold-green pollen; basistyle infuscated, darker spots near base and at articulation of distyle (fig. 15); aedeagal blades (figs. 17–21) curved, .04 mm. long; apex of distyle .03 mm. long; movable stylet expanded and bent apically.

Material examined:

1 ♂ (*paratype*); Aylmer, Quebec; November 7, 1924; C. H. Curran; (C). 5 ♂♂; Maine (on single cork); (C). 9 ♂♂; W. Springfield, Mass.; August 21, 1903; F. Knab.; (U.S.N.M.). 7 ♂♂; Mud Pond, McLean Res., N. Y.; August 17–30, 1925; (C). 2 ♂♂; Plummers Id., Md.; July 7, 1902; H. S. Barber; (U.S.N.M.). 1 ♂; Washington, D. C.; October 11, 1912; R. C. Shannon; (U.S.N.M.). 9 ♂♂; Billy's Id., Okefenokee Swamp, Ga.; June 1912; (C). 1 ♂; Wambay, S. D.; June 6, 1918; J. M. Aldrich; (U.S.N.M.). 1 ♂; Fallen Leaf, Lake Tahoe, Calif.; September 13, 1915; (U.S.N.M.).

Pentaneura (Ablabesmyia) auriensis Roback

1957. Acad. Nat. Sci. Phila. Monograph, 9: 39–40.

This species is close to *P. mallochi* and can be separated only by the abdominal maculation (fig. 45). The aedeagi (fig. 22) are very similar. Two greasy males in the U.S.N.M. collection from Sandpoint Id. appear to be this species.

Pentaneura (Ablabesmyia) aspera n. sp.

1957. *P. basalis* Roback nec Walley?[2] Acad. Nat. Sci. Phila. Monograph, 9: 40.

This species belongs to the *monilis* group and can be separated from all the species of that group, except *P. gera,* by the longer heavier aedeagal blades (figs. 5, 23–26) and the dorso-mesally approximated dorsal lobes (in natural position) (fig. 23). It can be separated from *P. gera* by the difference in proportion of the length of the aedeagal blade and the dorsal lobe.

The variation that can be obtained by mounting is illustrated in figs. 23–26. Fig. 23 shows the blade and dorsal lobe in natural position. In fig. 24, the hypopygium is slightly depressed and the aedeagus tilted. Fig. 25 shows another step in this process and in fig. 26, the aedeagus is completely flattened. This is the lateral view of the aedeagus as shown in fig. 23. To achieve the last step the hypopygium is completely crushed. The above variation, with mounting, emphasizes the need for caution in interpreting slight differences in shape.

Fig. 27 illustrates the aedeagus of the Douglas Lake specimen. Though it appears to differ from fig. 26, I have seen aedeagi in the Salisbury Cove series which approach it and it probably represents one end of the range of variation in the aedeagal blade.

Length—The following table gives the size range and distribution of these sizes among 62 specimens measured.

Length in mm.	3.30	3.48	3.60	3.72	2.90	3.96
Number of specimens ..	5	7	31	13	4	2

All measurements made under dissecting microscope with calibrated ocular grid.

The head and antennal scape dark brown; antennal flagellum and palpi lighter brown; antennal ratio from 1.9–2.1; the small terminal segment (fig. 3) about .11 mm. long; ratio of palpal segments 5 : 10 : 15 : 10 : 28; only the basal segment without setae; eyes distinctly produced above; closer above than below.

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[2] The specimen which the author identified as *P. basalis* in 1957 has distinct bulges on the basistyle. The aedeagal blades are everted (text-fig. 2 D) and do not appear to be sinuate, though it is impossible to be sure of this, and the spot at the edge of R_3 is lacking. It is tentatively assigned here.

Mesonotum (fig. 4); pleurae and sternum dark brown overlain by grey-gold pollen; vittae slightly darker, not too distinct; median vittae split with an irregular row of hairs in this gap; mesonotal hairs uniserial, spread out into a group of 8–9 hairs anterior to the lateral vittae (fig. 4) and a group of 5 hairs caudally; supra-alar hairs, 17; scutellum lighter than the mesonotum; with an irregular band of hairs across its apex; postnotum dark brown.

Coxae of foreleg and mesothoracic leg dark brown; metathoracic leg lighter brown; femora with preapical brown ring and basal two-thirds to three-quarters of the mesal edge infuscated; tibiae with sub-basal, mesal and apical brown rings; rings relatively narrow; first tarsal segment with wider mesal and apical rings; apical half of second and third tarsal segments infuscated; last two tarsal segments almost completely infuscated.

The following chart gives tibia–tarsi ratio of the foreleg, leg ratio (LR), and position of mesal rings of all three tibiae (I, II, III) and first tarsal segments; specimens recorded represent extremes in position of mesal tibial ring; measurements made from slide mounted material with an ocular micrometer. Dashes indicate missing portion of leg.

Foreleg		Tibia			First tarsal seg.		
tibia-tarsi	LR	I	II	III	I	II	III
96 : 73 : 53 : 37 : 24 : 14	.76	.50	.48	.42	.37	—	—
100 : 78 : 55 : 38 : 24 : 14	.78	.57	.59	.50	.40	.39	.40
96 : 77 : 51 : 35 : 24 : 14	.81	.59	.56	.51	.41	.40	—

Foretibia with a single spur (fig. 7) .04 mm. long; meso- and metatibia each with two unequal spurs (figs. 8 and 9). Those of the mesotibia .05 and .028 mm. long, those of the metatibia .067 and .028 mm.; claws bear 4 hairs on the side of the basal swelling; empodium present, slightly shorter than claws.

Wings 2.4 mm.+ long; marked, with some slight variation as in fig. 1; squamae fully fringed; halteres white.

First 5 abdominal tergites whitish, last three dark; tergite 1 unmarked except for a pair of dark spots at the base of the postnotum; tergite 2 often with short paired longitudinal brown marks; and occasionally a pair of oval brown marks near the base of the tergite (fig. 2); tergites 3 and 4 with variable paired longitudinal brown marks; paired marks on tergite 5 generally wider than those on tergites 3 and 4; may be joined by some lighter infuscation from their centers to caudal ends; occasionally tergites 1–5, almost completely clear, abdomen resembling that of typical *P. peleensis* (Walley); tergites 6 and 7 dark brown; tergite 8 brown basally and at its center, lighter toward its edges; longitudinal marks never fuse anteriorly to form brown triangles; typical abdominal pattern as in fig. 2; abdominal sternites up to 5 are clear, 6–8 marked as their tergites.

Basistyle of male genitalia with distinct dorso-lateral basal bulge; generally light in color with some infuscation near the base and near the

articulation of the distyle; movable stylet bent and flared apically (fig. 10), .021 mm. long; apex of distyle as in fig. 10; blade of the aedeagus relatively straight in dorsal view (fig. 5), .052–.062 mm.; dorsal lobes in natural position approximated, apically setose, lateral view (fig. 26); lateral lobe membranous, formed by fused filaments.

Holotype.— ♂ ; Salisbury Cove, Mt. Desert Island Biological Lab., Mt. Desert Island, Maine; July 9–24, 1957 (Drs. Hubert and Mabel Frings) [collection of Academy of Natural Sciences of Philadelphia, Type no. 6819.]

Paratypes.—40 ♂ ♂ ; same data as above. 5 ♂ ♂ ; same data as above. [U. S. National Museum.] 5 ♂ ♂ ; same data as above. [Cornell University.] 5 ♂ ♂ ; same data as above. [Illinois Natural History Survey.]

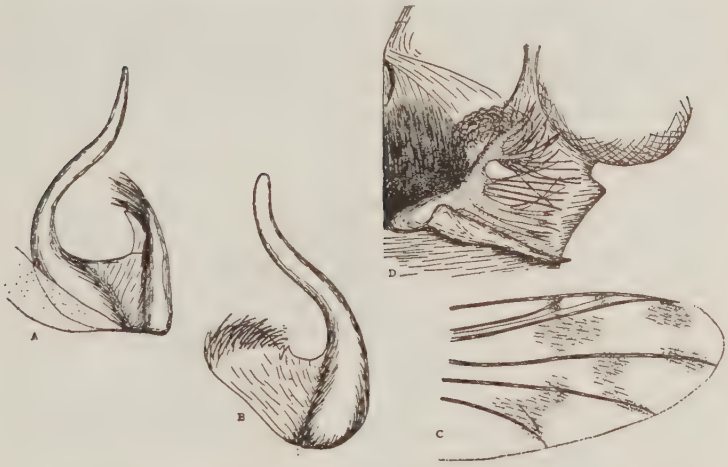
The following ecological data on *P. aspera* was graciously furnished the author by the collectors. The swarms consisted of ten to fifty individuals, hovering about 6 to 9 feet above the ground in open areas in woods. Each small clearing had about two to six of these swarms. They appeared a little before sunset and left shortly before dark. If disturbed by winds, they flew hurriedly back when the wind stopped, and reformed the swarms. These swarms were first noted July 5 and grew larger and more numerous during the collection period of July 9 to July 24, 1957. In 1958 swarms were taken from July 23–August 15.

Pentaneura (Ablabesmyia) gera n. sp.

This species is closely related to *P. aspera* but can be separated by the aedeagus. In *P. gera* the blade is longer than in *P. aspera* and is twice as long as the dorsal lobe. In *P. aspera* the blade is 1.5 times as long as the dorsal lobe.

Male.—About 3.0 mm.; head brown; antennae and palpi light brown; antennal ratio 2.15; mesonotum brown, vittae indistinct, 6–8 hairs anterior to lateral vittae; scutellum brown, slightly lighter than mesonotum; postnotum dark brown; leg ratio .8; position of mesal bands on foretibia and first foretarsal segment .57 and .40 respectively; abdominal tergites 1 and 2 whitish with some light infuscation, segments 3–6 missing; 7 and 8 dark; aedeagus as in fig. 37; blade .072 mm.; dorsal lobes approximated, .038 mm.

Holotype.—White Mts. (Morrison). [Type in U. S. National Museum, Type No. 65461.]



Text-figure 2.—*Pentaneura* (*A.*) *basalis* (Walley)—A, aedeagal blade, holotype; B, aedeagal blade, paratype; C, wing tip; *Pentaneura* (*A.*) *aspera?* Roback—D, right half aedeagal complex, everted position.

Pentaneura (Ablabesmyia) basalis (Walley)

1925. *Tanypus basalis.* Can. Ent., **57**: 273, 275.

The author has been able to examine a paratype and the genitalia of the holotype of this species and is now able to offer a more complete description of the species. The three spots along the outer margin of the wing (text-fig. 2C) seem to offer a good character to differentiate this species from *P. aspera* and *P. mallochi* which may superficially resemble it and most specimens of *P. monilis*. The aedeagal blade approaches *P. monilis* in length but the longer examples of *P. basalis* are heavier and the dorsal lobe is less well developed. The possibility exists that large series will show *P. basalis* and *P. monilis* to be one widely ranging polytypic species.

Male.—Length 3.0 mm.; antennal ratio 2.4; head brown; mesonotum brown, overlain by green-gold pollen; vittae not too distinct; 7–9 hairs anterior to lateral vittae; scutellum light; postnotum dark brown; wing 2.4 mm.; marked as in *P. aspera* except for spot over apex of R_3; spots over tip of R_{1+2} and tip of R_{4+5} dark (text-fig. 2 C); wing very hairy; foreleg ratio .78; segments of foreleg starting with tibia in ratio 8 : 6.2 : 4 : 3 : 1.8 : 1.2;

position of mesal band of foretibia .5; of first tarsal segment .45; abdomen appears to have stripe down center-longitudinal stripes closely approximated; basistyle with lateral bulges; blade of aedeagus (text-figs. 2 A and B) .058–.065 mm. long; dorsal lobe about .029 mm.; blade sinuate as in *P. monilis;* expanded apex of distyle .032–.035 mm.; ratio of length of aedeagus to apex of distyle 1.84–1.86.

Material examined:

1 ♂ (*Paratype*); Aylmer, Quebec; August 8, 1924; C. H. Curran; (C.N.M.). 1 ♂; Pt. Pelee, Ontario; May 16, 1925; G. S. Walley; (C.N.M.). 1 ♂; Pt. Pelee, Ontario; June 11, 1925; G. S. Walley; (A.N.S.P.). 1 ♂ (Slide of genitalia of holotype); (C.N.M.).

Pentaneura (Ablabesmyia) monilis (Linnaeus)

1758. *Tipula monilis.* Syst. Nat. Ed. X: 587.

This is a widespread and much misinterpreted species. It is common in North America and Europe. Thienemann (1941) considers it to be cosmopolitan.

P. punctulata (Philippi 1865) from Chile, *P. malus* (Hutton 1902) from New Zealand and *P. notabilis* (Skuse 1889) from Australia may be forms of this species (see Edwards 1931). The wing figured for *P. monilis* by Goetghebuer (1936 tab. 3, fig. 28) is undoubtedly not of that species. In the placement of the spot in cell M basad of that below R_{2+3} it appears to be close to *P. peleensis* (Walley) (fig. 16). The wings of specimens of *P. monilis* from Edwards in England and Kowarz in Austria are not clearly different from that of *P. mallochi* or *P. aspera.* Some specimens will show a faint spot at the apex of R_3.

The interpretation of *P. monilis* adopted here is that of Johannsen (1946) and is based on the aforementioned European material and some additional specimens from North America. The critical character in the determination of this species is the very distinctive aedeagus (figs. 28–31) first figured by Johannsen (1946). Externally the adult is like *P. mallochi* and the difficulty of identifying this species without reference to the aedeagus is illustrated by the fact that a series of specimens determined by as competent a worker as Dr. Johannsen contained in addition to *P. monilis, P. mallochi, P. aspera,* and *P. peleensis.*

The specimen from England is larger with a longer aedeagus (fig. 29) and darker than those from Austria (fig. 30) and the U. S. It may represent a geographical race but does not, from

Text-figure 3.—*Pentaneura* (*A.*) *monilis* (L.), male, lateral view.

the little material available, appear to be subspecifically distinct.

The following table compares some of the salient characteristics of the European and U. S. forms.

	Ithaca	Austria	England
Body length	3.0	3.0	3.8
Wing length	2.4	2.4	3.0
Abd. segs. 1–4	Whitish	Whitish	Dark
Foretibia : Tarsus 1 : Tarsus 2 : Tarsus 3	8 : 7 : 4.4 : 3	8 : 7 : 4.4 : 3	10 : 9 : 5.5 : 4
Leg ratio	.87	.87	.90
Aedeagal blade length ...	.075 mm.	.075 mm.	.096 mm.
Dorsal lobe of aedeagus ..	.036 mm.	.036 mm.	.036 mm.

The aedeagal complex of *P. monilis* is very unusual in that it is often everted (fig. 32) so that the bases of the lateral filaments

are on top and the aedeagal blades extend laterally in an inverted position. In lateral view this appears as in fig. 12. The African species *P. dusoleili* (Goetghebuer) and *P. pictipes* (Kieffer) exhibit a similar phenomenon. When turned forward the aedeageal complex appears as in fig. 28, and is similar to *P. aspera* (fig. 23). The blades are sinuate in the vertical plane (figs. 29–31) with the apex pointing downward. The apical section of the dorsal lobes (fig. 31) is difficult to discern and is omitted in figures 29 and 30.

The species in North America ranges from New York to Alaska.

Material examined:

1 ♂; Franzbd, Austria; F. Kowarz; (C). 1 ♂, 1 ♀; Det. Edwards, England; (C). 2 ♂♂; Ithaca, New York; O. A. J.; (C). 1 ♂; Blue Lake Station D., Ontario; May 27, 1957; (A.N.S.P.). 3 ♂♂; Timagami, Ontario; November 6, 7, 11, 1934; A. W. A . Brown; (C). 1 ♂; Mountain Home Lake, Ft. Garland, Colo.; Alt. 8,300 feet; July 20–25, 1932; (C). 1 ♂; Kaslo, B. C.; June 23; R. P. Currie; (U.S.N.M.). 1 ♂; Dutch Harbor, Alaska; July 15, 1944; (U.S.N.M.).

Pentaneura (Ablabesmyia) annulata (Say)

1823. *Tanypus annulatus.* Journ. Acad| Nat. Sci. Phila., 3: 15.
1915. *Tanypus monilis* Mall. nec Linné. Ill. State Lab. Nat. Hist. Bull., 10: 375.

The interpretation of this species accepted here is that of Johannsen (1946). Say's original description is naturally rather vague but his description " tibia with one annulus at base and two near the tip fuscous; wing with large obsolete dusky spots or clouds . . ." agrees much more closely with the description of the specimens which Dr. Johannsen interpreted as this species and with the specimens I have examined than it does with that of *P. monilis.* Both Walley (1928), and Zavřel and Thienemann (1921) have, I feel, incorrectly synonymized *P. annulata* with *P. monilis.* This is a widespread species commonly misdetermined as *P. monilis.*

Body 4.0–5.2 mm. long; antennae and head brown, antennal pedicel darker brown; antennal ratio about 2.3; thorax, scutellum and postnotum brown; scutellum slightly lighter; pleurae dark brown; vittae not distinct, pollinose, median vitta split with an irregular row of hairs down this space;

25+ setae anterior to the lateral vittae; wing 3.6 mm., figured by Malloch 1915, plate XXVII; squamae fully fringed; halteres lightly infuscated; leg ratio .73, femora with a preapical ring and light infuscation on basal two thirds; position of median foretibial tibial ring .75; tarsal ring .37 (fig. 42 c); rings narrow; abdominal tergites 2–5 with an anterior brown band and some infuscation behind; tergites 6–8 black brown; basistyle dark brown with a distinct lateral bulge near the base; apex of distyle .053 mm. long; resting position of aedeagus as in fig. 33; when flattened appears as in fig. 34; aedeagal complex tilted slightly upwards in sime specimens; blade .10–.14 mm. long; dorsal lobe .061–.073 mm., with 30+ filaments.

Material examined:

3 ♂♂; Wambay, S. D.; June 6, 1918; J. M. Aldrich; (U.S.N.M.). 8 ♂♂; Cairo, Ill.; July 25; H. G. Barber; (U.S.N.M.).

Pentaneura (Ablabesmyia) johannseni n. sp.

1946. *P. monilis* var. 2 Joh. Jour. N. Y. Ent. Soc. 54: 273.

On its external characters this species superficially resembles *P. monilis*. However, it is easily separable on aedeagal characters. The long slightly spinose lateral lobe (larger than the blade) and the triangular dorsal lobe (fig. 36) will differentiate it from all other *Pentaneura* (*Ablabesmyia*) species.

Male.—Length 2.4 mm.; head and thorax similar to *P. aspera;* leg ratio .77, position of foretibial mesal band .53; spur of foreleg .048 mm. long; wing 2.0 mm.; spots below tip of R_{4+5} and tip of M almost confluent; spots below R_{2+3} sub-basal in M, and at the apex of Cu_1 almost run together; abdomen almost completely brown; apex of distyle .036 mm. long; blade of aedeagus .050 mm. long, lateral lobe .089 mm., laterally spinose (fig. 36); lateral filaments short and curved.

Holotype.— ♂; Algonquin, Ill.; May 31, 1931 (W. A. Nason) [In collection of Cornell University].

Pentaneura (Ablabesmyia) janta n. sp.

1946. *P. monilis* var. 1 Joh. Jour. N. Y. Ent. Soc., 54: 272–273.

Externally this species does resemble *P. monilis*. However, a detailed examination of the aedeagus shows that it is not nearly as closely related to *P. monilis* as Johannsen assumed, but is more closely related to *Pentaneura johannseni* (*Petaneura monilis* var. 2 Joh.). The hairs at the tip of the lateral lobe and the short curved lateral filaments will separate this species from any others of this subgenus known to me. The females are not designated

as part of the type series inasmuch as there is some doubt in my mind as to the association.

Male.—Length, 2.7 mm.; head, thorax, and abdomen similar to that described and figured for *P. aspera* (figs. 2, 4); antennal ratio 2.1; wing length 2.4 mm.; maculation as in fig. 1; leg ratio .8; position of median tibial ring .5; fore-tarsal ring .39; aedeagus as in fig. 35; blade of aedeagus (.05 mm. long) only slightly longer than the apical section of the distyle; dorsal lobe apparently without hairs, two-thirds length of blade; lateral lobe about 1.4 times as long as blade and 1.7 times as long as apex of distyle; with a brush of filaments apically; Johannsen (1946) called this the aedeagal limb (aedeagal blade).

Female.—Length, 2.0 mm.; antennae and palpi light brown; antennal segments in ratio 15 : 7 : 7 : 7 : 7 : 7 : 7 : 8 : 8 : 8 : 30; mesonotal vittae dark brown, distinct; median vittae split with irregular row of hairs down center; scutellum light, same as ground color of notum; postnotum dark brown; leg ratio .79–.81; mesal fore-tibial band position .5; wing 2.4 mm. long; abdomen brown, darker mesally; ventral genital plate as in fig. 43; genital claspers .057 mm. long; three dark spermathecae .048 mm. long; tubes setose.

Holotype.— ♂ ; Plummers Island, Md. (at light); May 23, 1914 (R. C. Shannon) [U.S.N.M., Type no. 64562.]

Additional specimens:

2 ♀ ♀ ; same data as holotype except May 14, 1913 (U.S.N.M.).
1 ♂ ; same data as holotype except October 10, 1914 (U.S.N.M.).

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Explanation of Figures

Plate XIV

Pentaneura (*A.*) *aspera* n. sp.

Fig. 1.—Wing.
Fig. 2.—Abdomen, dorsal view.
Fig. 3.—Apical segment of male antenna.
Fig. 4.—Mesonotum, scutellum, and postnotum, lateral view.
Fig. 5.—Aedeagal complex, right half.
Fig. 6.—Hypopygium, dorsal view.
Fig. 7.—Spur of foretibia.
Fig. 8.—Spurs of mesotibia.
Fig. 9.—Spurs of metatibia.
Fig. 10.—Apex of distyle, and side view of movable stylet.
Fig. 11.—*Pentaneura* (*A.*) *monilis* (L.)—dorsal view of apex of distyle.
Fig. 12.—*Pentaneura* (*A.*) *monilis* (L.)—lateral view of hypopygium and eighth abdominal segment.
Fig. 13.—*Pentaneura* (*A.*) *illinoensis* (Mall.)—lateral view apex of distyle.
Fig. 14.—*Pentaneura* (*A.*) *mallochi* (Walley)—spur of foretibia.
Fig. 15.—*Pentaneura* (*A.*) *mallochi* (Walley)—left half, hypopygium.
Fig. 16.—*Pentaneura* (*A.*) *peleensis* (Walley)—wing.

Plate XV

Pentaneura (*A.*) *mallochi* (Walley)

Aedeagal blade and dorsal lobe

Fig. 17.—Relaxed position (from paratype).
Fig. 18.—Completely flattened (Georgia).
Fig. 19.—Partially flattened (Mclean Reservoir, N. Y.).
Fig. 20.—Relaxed (Mt. Washington).
Fig. 21.—Relaxed (South Dakota).

Pentaneura (*A.*) *auriensis* Roback

Fig. 22.—Aedeagal blade and dorsal lobe, vertical view, partially flattened.

Pentaneura (*A.*) *aspera* n. sp.

Aedeagal blades and dorsal lobes

Fig. 23.—Relaxed position.
Fig. 24.—Blade and lobe, slightly tilted.
Fig. 25.—Blade and lobe, two-thirds tilted.
Fig. 26.—Blade and lobe, completely flattened, lateral lobe and some filaments shown.
Fig. 27.—Blade and lobe, two-thirds tilted (Douglas Lake).

Pentaneura (*A.*) *monilis* (L.)

Aedeagal blades and dorsal lobes

Fig. 28.—Relaxed position.
Fig. 29.—Lateral view of blade and part of dorsal lobe (England).
Fig. 30.—Lateral view of blade and part of dorsal lobe (Austria).
Fig. 31.—Blade and dorsal lobe, two-thirds tilted with some filaments shown (Colorado).
Fig. 32.—Aedeagal complex, everted position.

PLATE XVI

Pentaneura (*A.*) *annulata* (Say)

Fig. 33.—Aedeagal complex, relaxed position.
Fig. 34.—Half of aedeagal complex, completely flattened.

Pentaneura (*A.*) *janta* n. sp.

Fig. 35.—Half of aedeagal complex.

Pentaneura (*A.*) *johannseni* n. sp.

Fig. 36.—Half of aedeagal complex.

Pentaneura (*A.*) *gera* n. sp.

Fig. 37.—Half of aedeagal complex.

Pentaneura (*A.*) *illinoensis* (Malloch)

Fig. 38.—Aedeagal blade and dorsal lobe—relaxed position.
Fig. 39.—Aedeagal blade and dorsal lobe—completely flattened.

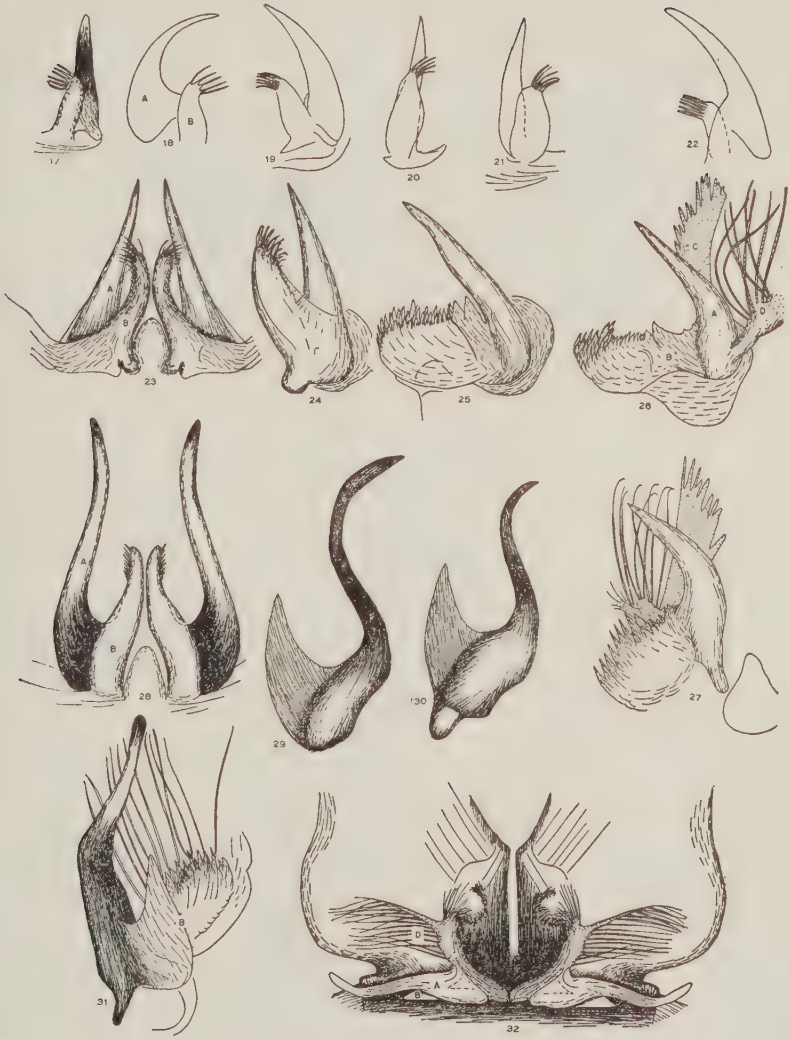
Pentaneura (*A.*) *peleensis* (Walley)

Fig. 40.—Aedeagal blade and dorsal lobe—slightly flattened.
Fig. 41.—Aedeagal blade and dorsal lobe—relaxed position.

Plate XVII

Fig. 42.—Foretibia and first tarsal segment.
a.—*Pentaneura* (*A.*) *cinctipes* Johannsen.
b.—*Pentaneura* (*A.*) *illinoensis* (Malloch)
c.—*Pentaneura* (*A.*) *annulata* (Say)
d.—*Pentaneura* (*A.*) *mallochi* (Walley)
e.—*Pentaneura* (*A.*) *monilis* (L.) (England).
f.—*Pentaneura* (*A.*) *monilis* (L.) (U. S.).
Fig. 43.—*Pentaneura* (*A.*) *janta* n. sp.—female genitalia, ventral view.
Fig. 44.—*Pentaneura* (*A.*) *peleensis* (Walley)—abdomen, dorsal.
Fig. 45.—*Pentaneura* (*A.*) *auriensis* Roback—abdominal segments 1–5, dorsal.
Fig. 46.—*Pentaneura* (*A.*) *mallochi* (Walley)—abdomen, dorsal (Ithaca).
Fig. 47.—*Pentaneura* (*A.*) *monilis* (L.)—right half of hypopygium, dorsal.
Fig. 48.—*Pentaneura* (*A.*) *illinoensis* (Malloch)—right half of hypopygium, dorsal.
Fig. 49.—*Pentaneura* (*A.*) *peleensis* (Walley)—left half of hypopygium, dorsal.

ROBACK: SUBGENUS ABLABESMYIA



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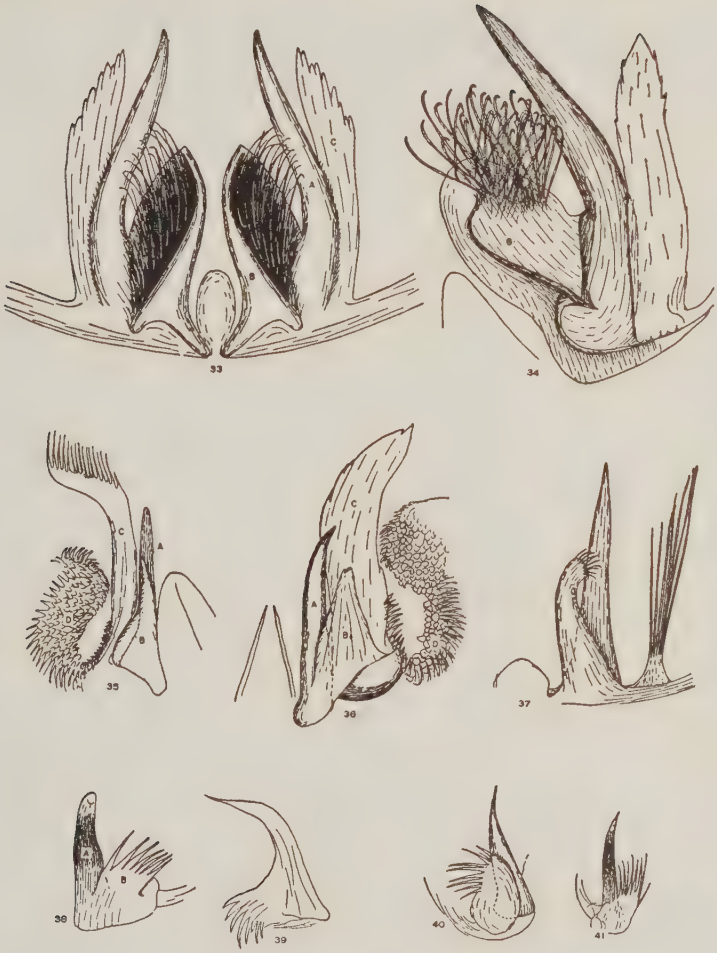
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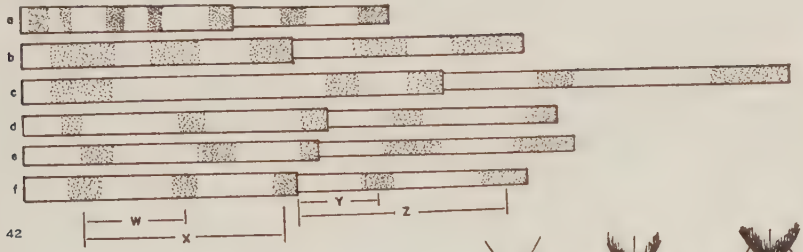

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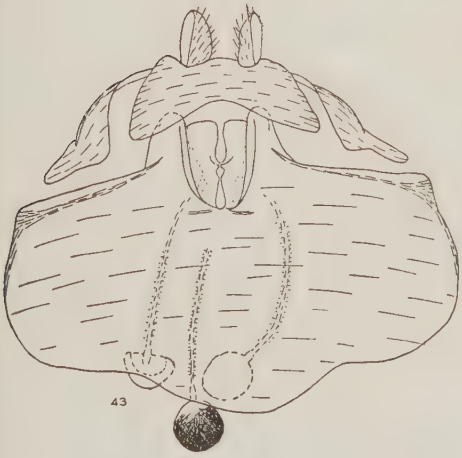

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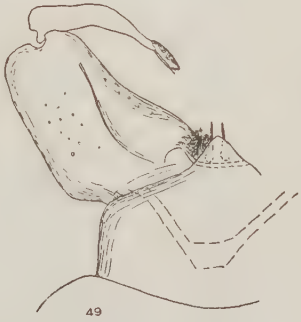

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STUDIES ON THE LARVAE OF DIGGER WASPS (HYMENOPTERA, SPHECIDAE) PART V: CONCLUSION[1]

BY HOWARD E. EVANS
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(Plates XVIII to XXIV)

This is the concluding number of a series of papers on the larvae of digger wasps. It covers two groups not treated earlier: the tribe Psenini and the subfamily Mellininae. Also included are numerous additions and a few corrections to groups already covered. A concluding section includes a table of subfamily characters, a working key to Nearctic genera, and a discussion of the phylogeny and classification of the Sphecidae as indicated by larval characters.

Throughout this paper I have referred to earlier papers in this series by Roman numeral only. Complete references to these papers are as follows:

Part I: Sphecinae. Trans. Amer. Ent. Soc., 81: 131–153, pls. I to VIII. January 1956. (With C. S. Lin.)

Part II: Nyssoninae. Ibid., 82: 35–66, pls. II to XIV. August 1956. (With C. S. Lin.)

Part III: Philanthinae, Trypoxyloninae, and Crabroninae. Ibid., 83: 79–117, pls. IX to XX. September 1957.

Part IV: Astatinae, Larrinae, and Pemphredoninae. Ibid., 84: 109–139, pls. II to VIII. July 1958.

Part I contains a general introduction to the study and it seems unnecessary to repeat the information presented there. I would, however, like to add one note. These studies are based primarily

[1] Acknowledgment is made to the Grace H. Griswold Fund of the Department of Entomology of Cornell University for assuming the cost of engraving the plates. Many of the larvae described here were collected in the course of studies on the comparative ethology of digger wasps, a project supported by the National Science Foundation.

on fully grown larvae which have not yet spun their cocoons. When the cocoon has been spun the larvae void their meconium, enter diapause, and assume a more compact body form with the individual segments often much compressed and thrown into dorsal and ventral prominences; some wear of the mandibles and deterioration of the spinnerets can also often be noted at this time. In these studies, wherever I have had to use such larvae I have clearly stated that they were " diapausing larvae " or larvae " taken from a cocoon ". The term " prepupa " is also often used for such larvae. It is to be assumed that wherever I have failed to indicate otherwise, the larvae described are active, full-grown larvae which have not yet spun their cocoons.

Acknowledgments

Since these studies were initiated several persons have contributed specimens, and I wish at this time to add to the acknowledgments made in Part I. Karl V. Krombein, of the Entomology Research Division, Agricultural Research Service, Washington, D. C., has continued to send me many well preserved larvae taken in the course of his biological studies. George E. Bohart, of the U. S. Legume Seed Research Laboratory, Logan, Utah, has contributed a number of larvae taken in Utah and in California. Both of these collections contained many twig-dwelling forms which I have never taken in my studies of fossorial species. Richard M. Bohart, Jerry A. Powell, and Paul D. Hurd, Jr., of the University of California at Davis and at Berkeley, have all sent me valuable specimens from their state. Entomologists of the Hawaiian Sugar Planters' Association have loaned me several slides of larval heads made by F. X. Williams, and Dr. Williams himself has sent me larvae of *Pisonopsis*. Professor O. W. Richards, of the Imperial College of Science and Technology, London, England, went to considerable trouble to collect larvae of *Mellinus*, which I would otherwise not have been able to obtain. Without the cooperation of these individuals many species, several genera, and one subfamily would have had to have been omitted from consideration in these papers.

Subfamily Pemphredoninae, Tribe Psenini

In Part IV I remarked that the psenines have very different larvae from the Pemphredoninae and would have to be treated as a separate subfamily. When I wrote this I had not had an opportunity to study the larva of *Diodontus*. Now that I have, I find it necessary to retract this statement. It is true that most psenine larvae differ markedly from the Pemphredoninae, but *Diodontus* is in several respects intermediate between the two groups. The characters listed for the Pemphredoninae in Part IV, then, apply only to the tribe Pemphredonini. The following characters will serve to define the tribe Psenini.

Characters of the tribe.—Pleural lobes prominent, in diapausing individuals often conical; anus directed caudad, situated below the middle of the terminal segment; body setae very short, sparse, and inconspicuous; integument at least sparsely spinulose, in some genera clothed everywhere with dense, fairly long spinules; spiracles with the atrium lined with weak, anastomosing ridges, the opening into the subatrium small, simple. Head higher than wide or, in *Diodontus*, wider than high; parietal bands weak or absent; antennal orbits large, circular, antennal papillae present; head setae very sparse and inconspicuous. Labrum with many punctures on the disc, some of them bearing setae; apex always with a series of small, nipple-like sensilla; epipharynx weakly spinulose on the sides, the central area mostly bare but containing several peg-like sensilla. Mandibles elongate or, in *Diodontus*, short and heavy; base with a single seta; apex with three or four teeth. Maxillae with the palpi large, the galeae considerably smaller, the lacinial area spinulose and produced mesad, in some genera so much so that the two maxillae nearly touch on the midline just beyond the transverse hypopharynx; apex of labium without spinules or papillae, the spinnerets slightly to considerably longer than the palpi, acute or truncate apically, tending to arise from a common base.

Table of Generic Characters

A. Head broader than high (fig. 13); mandibles broad and short, terminating in four teeth which surround a strong concavity (fig. 16); spinnerets truncate apically; integument with sparse, short spinules (fig. 14).

Diodontus (*atratus parenosas*, [*atratus atratus*, *fuscipennis*])

AA. Head higher than broad (fig. 1); mandibles slender, the three or four apical teeth all in about the same plane (figs. 20, 22); spinnerets acute apically (fig. 10); integument with dense, rather long spinules (figs. 2, 8).

B. Apical abdominal segment with a conical protuberance above the anus (fig. 3); integument granulose, each granule giving rise to a spine (fig. 2) ..... *Pluto* (*albifacies* ?)

BB. Apical abdominal segment rounded (fig.12); integument spinulose, but not or scarcely granulose (fig. 8).

C. Apical margin of labrum with a row of very small, nipple-like sensilla (fig. 21); labrum not or barely emarginate medially; mandibles with only three distinct teeth (fig. 22) ..... *Mimesa* (*nigra*, [*bicolor*])

CC. Apical margin of labrum with a series of convexities, each bearing a small sensillum (fig. 7); labrum emarginate.

D. Mandibles with four teeth (as in fig. 1); spinnerets rather short.

Psen (*Pseneo*) (*simplicicornis*, sp.)

DD. Mandibles with only three distinct teeth (fig. 20); spinnerets long and spine-like.

Psen (*Psen*) (*barthi*, [*ater*])

Pluto albifacies (Malloch) (?) [2] (Plate XVIII, figs. 1–6)

Body.—Length 5 mm.; maximum width 1.3 mm. (fig. 3). Fusiform, strongly tapered both anteriorly and posteriorly; segments convex dorsally; apical abdominal segment with its dorsal margin prolonged as a conical lobe well above the anus. Body surface noticeably roughened, even under low power, by dense, evenly distributed small granules, each of which gives rise to a short or (dorsally) fairly long spine; body setae sparse, no longer than the spines (fig. 2). Spiracles with the atrium weakly lined with ridges, the subatrium slender, leading directly into the slender trachea (fig. 5).

Head.—Higher than wide; width .56 mm.; height .66 mm. (fig. 1). In lateral view, the profile of the head is irregular, the front having a strong elevation between the orbits and a pair of low tubercles above this. Coronal suture weak but fairly long; parietal bands absent; epistomal suture

[2] Two specimens associated with nests from which larvae were collected were identified questionably as this species by K. V. Krombein. This genus is much in need of revision.

strong. Antennal orbits 55 μ in diameter; antennal papilla large, about 50 μ long and 18 μ in maximum diameter. Setae few in number, the longest ones about 25 μ long.

Mouthparts.—Labrum .22 mm. wide, .08 mm. high; disc with fourteen strong setae, all toward the margin, which is weakly spinose and also has a few small sensory cones toward the midline (fig. 4). Epipharynx mostly bare, with a few weak spinules laterally and apically and a few small sensilla on the disc. Mandibles slender, .31 mm. long by .14 mm. in maximum width, with a single basal seta, the inner margin with four teeth in about the same plane, the penultimate weaker than the others. Maxillae broad apically, the inner margin with a strong extension mesad which is clothed densely with spinules, the two maxillae almost meeting on the midline; palpi large, 55 μ long by 25 μ wide at the base; galeae smaller, 25 μ long by 15 μ wide at the base (fig. 6). Apex of labium rather broad, subtruncate; palpi 55 μ long; spinnerets horn-shaped, slightly exceeding the palpi; laterad of each palpus is a strong seta arising from a small knob.

Material.—Two specimens from nests in a clay bank along the Red River, Wilbarger Co., Texas, July 5, 1956 (H. E. Evans).

Psen (Pseneo) sp. (Plate XVIII, figs. 7–12)

Body (diapausing larva).—Length 9 mm.; maximum width 4.5 mm. Fusiform, broad, somewhat depressed; pleural lobes prominent, conical; segments with dorso-lateral prominences, between which they are rather flat, apical abdominal segment forming a smoothly rounded lobe, the anus located on the lower side of it (fig. 12). Integument entirely clothed with small spinules which do not arise from distinct granules as in *Pluto*, the integument therefore having a much less granular appearance under low power (fig. 8).

Head.—Width 1.1 mm.; height 1.2 mm. Coronal suture weak; parietal bands absent; epistomal suture weak and apparently extending upward and forming an angle on the midline between the antennae. Antennal orbits 100 μ in diameter; antennal papilla short, 30 μ long and nearly as wide at the base (fig. 11). Head setae sparse, very small, the longest ones only about 20 μ long; clypeus with a row of minute setae.

Mouthparts.—Labrum .4 mm. wide, .2 mm. in maximum height, the apical margin with a deep median notch; disc with about thirty strong setae and with a series of dome-like elevations near the margin, which is bristly (fig. 7). Epipharynx weakly papillose, with a few spinules apically, sensory cones small, few in number. Mandibles much as in *Pluto albifacies*, .58 mm. long by .28 mm. in maximum width, inner margin with four teeth in the same plane, the penultimate very weak. Maxillae broad apically, the lacinial area strongly extended mesad and with numerous short, straight spinules; palpi large, about 110 μ long; galeae much smaller, about 50 μ

long (fig. 9). Labial palpi 80 μ long; spinnerets horn-shaped, slightly exceeding the palpi; labium with a few setae but without spines or papillae (fig. 10).

Material.—A single larva taken from cocoons found with associated leafhopper remains in flowerpots at Severn, Maryland, Sept. 11, 1954 [U. S. Nat. Mus.]. Three other cocoons were saved but nothing emerged from them. Both cocoons and larva closely resemble those of the following species; in fact, the two may be the same.

Psen (Pseneo) simplicicornis Fox

This species is described from a single cast skin taken from a cocoon. The body form is not preserved but the integument appears to be densely spinulose as in the preceding species.

Head.—Antennal orbits 100 μ in diameter; antennal papilla very short, about 25 μ long and nearly as broad, arising from a slight elevation in the orbit. Setae sparse and inconspicuous, at most 15 μ in length.

Mouthparts.—Labrum emarginate apically, disc with numerous setae, apical margin bristly; epipharynx spinulose laterally and apically, otherwise weakly papillose. Mandibles .53 mm. long, .24 mm. wide at the base; inner margin with four teeth, the penultimate very weak. Maxillae virtually identical to those of the preceding species; labium not well preserved in available material.

Material.—Cast skin removed from a cocoon from which an adult was reared; cocoon collected Sept. 28, 1908, at Harrisburg, Pa. (P. B. Myers) [U. S. Nat. Mus.].

Psen (Psen) barthi Viereck (Plate XIX, fig. 20)

This species is also described from a cast skin taken from a cocoon.

Body.—Integument wholly covered with rather dense, long spinules, the longest ones about 30 μ in length; setae very sparse, scarcely longer than the longest spinules. Spiracles with the atrium lined with numerous anastomosing ridges, the opening into the subatrium small, simple.

Head.—Antennal orbits 90 μ in diameter; antennae very short, about as in the preceding species. Setae few in number, the longest only about 20 μ in length.

Mouthparts.—Labrum and epipharynx very much as illustrated for *Psen* (*Pseneo*) sp. (fig. 7) except the spinules of the epipharynx slightly larger and more numerous. Mandibles .55 mm. long, .26 mm. in maximum width, very similar to the preceding two species but the penultimate tooth of

these species lacking, the apex thus tridentate (fig. 20). Maxillae much as illustrated for *Psen* (*Pseneo*) sp. (fig. 9); palpi large, 110 μ long by 50 μ in maximum width; galeae 60 μ long. Labium not well preserved in available material.

Material.—Cast skin removed from cocoon from which an adult was reared; cocoon collected Sept. 28, 1908, at Harrisburg, Pa. (P. B. Myers) [U. S. Nat. Mus.].

Psen (Psen) ater (Fabricius)

A description of the larva of this species, the type of the genus, has recently been provided by Janvier (1956, Ann. Soc. Ent. France, 124: 200–203). The body of the diapausing larva is very similar to that of *Psen* (*Pseneo*) sp., described above; the anal segment is similarly rounded, the anus somewhat ventral in position; the integument is covered with close-set short spines. Weak parietal bands are apparently present. The mandibles are slender and tridentate, as figured for *barthi*. The apex of the maxilla bears short spinules and the palpi are much longer and thicker than the galeae. The spinnerets are long and spine-like, about twice as long as the labial palpi.

Mimesa nigra (Packard) (Plate XIX, figs. 21–22)

Body (diapausing larva).—Length 5 mm.; maximum width 1.5 mm. Pleural lobes prominent and conical on the first eight abdominal segments, these segments also with small, paired ventral protuberances and prominent dorso-lateral elevations between which the dorsum is rather flat; anal segment forming a rounded lobe, with the anus somewhat ventral in position (as in fig. 12). Integument spinulose (as in fig. 8).

Head.—Slightly higher than wide. Coronal suture, parietal bands, and epistomal suture not visible. Antennal orbits 65 μ in diameter, antennal papilla short, 20 μ long and nearly as thick. Front and sides of head with scattered short setae, the longest 15 μ long; clypeus with a row of small setae.

Mouthparts.—Labrum .22 mm. wide, .09 mm. high; disc with ten strong setae; margin slightly bristly and with a row of twelve nipple-like sensilla (fig. 21). Epipharynx weakly spinulose except for a large area medioapically, which is bare. Mandibles somewhat triangular, .35 mm. long by .21 mm. wide at the base, the apex with three teeth in the same plane, the middle one very weak (fig. 22). Maxillae broad apically, the lacinial area prominent, with short, straight spinules; palpi 60 μ long, quite stout; galeae much more slender, 40 μ long. Apex of labium smooth except for a few setae; palpi 50 μ long; spinnerets horn-shaped, exceeding the palpi slightly.

Material.—One larva removed from a cocoon dug from cells in rotting wood, Falls Church, Va., June 2, 1951 (A. B. Gurney) [U. S. National Museum]. (See Gurney, 1951, Proc. Ent. Soc. Wash., 53: 280.)

Mimesa bicolor Shuckard

Janvier (1956, Ann. Soc. Ent. France, 124: 203–208) has described the larva of this European species. The body form is very similar to that of *nigra*. The antennae are short, but arise from an elevation of the orbit. The mandibles are slender and have two large concavities along the inner margin, much as in *nigra* but with the penultimate tooth replaced by a concavity. The maxillae are shaped as in *nigra* and similarly spinulose; the palpi are considerably longer and thicker than the galeae. The spinnerets are widely separated, sharply pointed, and about 1.5 times the length of the labial palpi.

Diodontus atratus parenosas Pate (Plate XIX, figs. 13–19)

Body.—Length 7.5 mm.; maximum width 1.8 mm. Fusiform-cylindrical, with rather even contours; pleural lobes moderately strong on the abdomen; each abdominal segment with a pair of large, oval dorso-lateral convexities; anus directed cauded but situated below the middle of the segment, the supra-anal lobe large, rounded, extending well beyond the smaller subanal lobe (fig. 15). Spiracles with the aperture large, the atrium lined with very fine anastomosing ridges; opening into subatrium small, simple; subatrium with several swellings and then suddenly tapered to a narrow thread (fig. 18). Integument apparently smooth, but under high magnification seen to bear small spinules which are separated from one another by more than their own length (fig. 14); these spinules are absent on some parts of the body.

Head.—Width .61 mm.; height .54 mm. (fig. 13). Nearly circular in anterior view; essentially unpigmented except for the mandibles and their articulations, which are brown, and the palpi and galeae, which are light brown; coronal suture and parietal bands not visible. Antennal orbits 65 μ in diameter; antennal papilla slender, 45 μ long. Setae very few in number but fairly long, the longest measuring about 30 μ.

Mouthparts.—Labrum .2 mm. wide, .08 mm. high; apical margin truncate, without bristles but with several sensory cones set in the margin; disc with numerous short setae plus a number of punctures (fig. 17). Epipharynx mostly bare, with an area of small spinules on each side apically; each side with four sensory cones not far from the midline. Mandibles very short and heavy, length .21 mm., maximum width .14 mm.; apex with four strong

teeth surrounding a strong ventral concavity (fig. 16). Maxillae somewhat produced mesad apically, the lacinial area weakly spinulose; galeae very small, only about 15 μ long; palpi larger, 45 μ long (fig. 19). Apical portion of labium more or less spherical; palpi short, about 25 μ long; spinnerets slightly exceeding the palpi, blunt apically, the two connected basally by a membrane.

Material.—Two specimens from trap nests, Arlington, Va., June 1958 (K. V. Krombein).

Diodontus atratus atratus (Fabricius)

Micheli (1930, Mem. Soc. Ent. Italiana, 9: 58–60) has provided a brief description of the larva of this European form (under the name *Psen pallipes* Panzer). There seem to be no important differences from *atratus parenosas,* although Micheli shows a larger number of spinules and sensory cones on the epipharynx.

Diodontus fuscipennis (Dahlbom)

Grandi (1934, Boll. Lab. Ent. Bologna, 7: 70–74) has described and figured the larva of this Palaearctic species in great detail. The body closely resembles that of *atratus parenosas,* including the large supra-anal lobe and the conspicuous dorso-lateral prominences. The head is slightly broader than high; the antennal papilla is slender and fairly long; head setae are sparse and small. The labrum is weakly emarginate apically and has a larger number of sensory cones than in *atratus parenosas;* the epipharynx is weakly but rather extensively spinulose on the sides. The mandibles closely resemble those of *atratus parenosas.* The lacinial area of the maxilla is short, directed toward the labium, and clothed with small spinules. The spinnerets are close together, arising from a common base; they are truncate apically and only slightly longer than the labial palpi.

Subfamily Mellininae

In Part II, pp. 36–37, I stated that, on the basis of larval characters, *Mellinus* could not be included in the Nyssoninae. At that time I was familiar with *Mellinus* only by way of Maneval's description of the larva of *M. arvensis.* This larva appeared to have so many unusual features that I preferred to

postpone treating it until I was able to obtain specimens for my own study. Thanks to O. W. Richards I have now been able to study the larva of *M. arvensis*. In most details it agrees closely with Maneval's description and figures, and I am more than ever convinced that *Mellinus* deserves being placed in a subfamily of its own.

Since the larva of only one species of this group is known, the usual subfamilial diagnosis will be omitted.

Mellinus arvensis (Linnaeus) (Plate XX, figs. 23–30)

Maneval (1939, Ann. Soc. Ent. France, 108: 64–66) has provided a description and a good series of figures of the larva of this same species. However, it seems in order to present a full description of the specimen before me, since the larvae of this group have so many unusual features; also, this specimen appears to differ from Maneval's in a few details.

Body (diapausing larva).—Broad, somewhat depressed; maximum length about 8 mm.; maximum width nearly 5 mm. (fig. 23). Apical abdominal segment forming a rounded lobe, the anus distinctly ventral in position and directed ventrad; pleural lobes prominent, conical, brown-tipped; each segment with a pair of similar conical, brown-tipped prominences located dorso-laterally. Integument smooth, without setae or spinules except on the tips of the pleural and dorso-lateral prominences which are capped with a series of short, dark spinules and a very few small setae (fig. 27). Spiracles small, brown, the orifice large but the peritreme not well-defined; walls of the atrium lined with ridges which form irregular polygons; opening into the subatrium small, simple; subatrium very short, with a narrowed portion leading to the trachea (fig. 25).

Head.—Subcircular in anterior view; width 1.2 mm.; height 1.15 mm. (fig. 24). Coronal and epistomal sutures not distinct; parietal bands indicated only by very faint, unpigmented lines. Antennal orbits broadly elliptical, oblique, measuring 65×80 μ, the three sensilla in a triangle in the center. Setae sparse and inconspicuous, the longest ones about 20 μ long.

Labrum.—Width .36 mm., maximum height .15 mm.; apical margin bristly and with a strong V-shaped emargination; disc with about twelve strong setae plus a few punctures and a subapical row of small sensilla (fig. 29). Epipharynx strongly spinulose apically and laterally, toward the base papillose. Mandibles .29 mm. wide at the base, .56 mm. long, without any noticeable setae; inner margin strongly excavated about half way out, beyond that point bidentate, the space between the teeth nearly straight, somewhat blade-like (fig. 30). Hypopharynx strongly bilobed, strongly spinulose. Maxillae with numerous lateral setae; palpi 75 μ long; galeae

slightly more slender and only 65 μ long; lacinial area strongly spinulose, rather strongly produced mesad (fig. 26). Apex of labium smooth, rather broad; labial palpi 70 μ long; spinnerets slender and pointed, measuring 130 μ from the base, connected by a membrane in the manner illustrated (fig. 28).

Material.—A single larva from a cocoon, Silwood Park, Berkshire, England, Sept. 27, 1957 (O. W. Richards).

Additions and Corrections To Parts I–IV

Subfamily Sphecinae

The following should be added to the subfamilial diagnosis presented in Part I, pp. 136–137: integument always bearing minute spinules at least on some parts of the body; spiracles with the opening between the atrium and subatrium always armed with a circlet of spines; mandibles never bearing setae, but always with a group of very small pores (sensilla?) near the base laterally; hypopharynx spinulose, weakly bilobed, not protruding and quite inconspicuous; maxillae directed mesad, the inner margin short, always strongly spinulose; apex of labium extremely broad.

Prionony x atratus (Lepeletier)

The spiracles of this species, not previously described, appear to resemble closely those of the genus *Sphex*. The integument, in both this species and *thomae*, bears simple spinules over much of its surface; only on parts of the venter do the spinules arise from plate-like bases as figured (Part I, fig. 18). Many other Sphecinae have similar spinules on the venter, and this cannot be considered a generic character for *Prionony x* as previously suggested.

Isodontia auripes (Fernald)

Reference to this species (Part I, p. 144) should properly have been followed by a question mark, since no adults were successfully reared from this material. However, Karl V. Krombein has recently sent me a larva definitely known to be that of this species. This larva is 24 mm. long, the head capsule 1.4 mm.

wide by 1.35 mm. high. In general, it agrees closely with the descriptions of *harrisi* and *auripes* previously presented, there being no notable specific differences between the larvae of these two species except perhaps in size as expressed by head capsule width.

Ammophila aberti Haldeman (Plate XX, figs. 31–33)

Body.—Length 18 mm.; maximum width 5.5 mm. Form much as described and figured for *A. procera* (Part I, p. 145, fig. 42). Anterior portion of each posterior annulet prominent; anus transverse, terminal. Integument spinulose.

Head.—Width 1.1 mm.; height about the same. Coronal suture strong; parietal bands brown, .25 mm. long; front with a pair of brown blotches in the middle and another pair just mesad of the orbits. Antennal orbits transversely elliptical, with a thick, pigmented rim; maximum diameter 80 μ. Front very sparsely punctate, the clypeus somewhat more densely so.

Mouthparts.—Labrum .55 mm. wide; apical margin deeply emarginate; both basal and apical margin with a thick, pigmented band, the median line also somewhat pigmented; disc of each lateral lobe with numerous punctures (fig. 31). Epipharynx with strong spinules, those on the median area directed inward; sensory areas each with 6–8 pores. Mandibles .5 mm. long and .24 mm. wide at the base, as shown in figure 32. Maxillae punctate laterally; palpi conical, 60 μ long; galeae also conical, 90 μ long; lacinial area with dense, short spinules; labial palpi 80 μ long; spinneret a transverse slit .5 mm. long (fig. 33).

Material.—Two specimens from beach of Laguna Madre, near Port Isabel, Texas, May 10, 1958 (H. E. Evans).

Ammophila placida Smith (Plate XXI, fig. 34)

Body.—Length 18 mm.; maximum width 5.5 mm. Pleural lobes prominent; anterior part of each posterior annulet prominent. Integument spinulose.

Head.—Maximum width .95 mm.; height .9 mm. Parietal bands lightly pigmented, about .3 mm. long; other areas of pigmentation as in the preceding species. Antennal orbits transversely ovoid, 75 μ in maximum diameter. Punctures of front and clypeus very sparse.

Mouthparts.—Labrum .46 mm. wide; features much as in *aberti;* median spines of epipharynx smaller and less strongly directed basad (fig. 34). Mandibles .45 mm. long, essentially as figured for *aberti.* Maxillary palpi conical, 70 μ long; galeae also conical, 90 μ long; lacinial area with dense, short spinules; labial palpi 80 μ long; spinneret a transverse slit .45 mm. long.

Material.—Six specimens from beach of Laguna Madre, near Port Isabel, Texas, May 10, 1958 (H. E. Evans).

Ammophila pruinosa Cresson (Plate XXI, fig. 35)

Body.—Length 14 mm.; maximum width 4 mm. Form as figured for *procera* (Part I, fig. 42). Integument conspicuously spinulose. Spiracular atria lined with weakly spinose, anastomosing ridges.

Head.—Width .8 mm.; height .83 mm. Coronal suture strong; parietal bands brown, .2 mm. long; front with a pair of conspicuous brown blotches in the middle; antennal orbits subcircular, small, 45 μ in diameter. Front almost impunctate, but the clypeus with numerous scattered punctures.

Mouthparts.—Labrum .37 mm. wide, differing from the preceding two species only in minor details as figured (fig. 35). Mandibles .4 mm. long, .19 mm. wide at the base, the apex with four strong teeth, the basal tooth stronger and sharper than figured for *aberti*. Maxillary palpi 45 μ long; galeae 60 μ long; lacinial area rather weakly spinulose; labial palpi 40 μ long; spinneret a transverse slit .3 mm. long.

Material.—Two specimens from Hopkins Well, Riverside Co., Calif., April 18, 1958 (J. Powell).

Chalybion californicum (Saussure)

Several adults of this species were reared from the series of cocoons from which the larvae described were taken, thus confirming this identification (Part I, p. 149).

Podium carolina Rohwer

Karl V. Krombein has recently sent me two additional larvae of this species taken from trap nests at Lake Placid, Florida, March 25 and April 2, 1957. These larvae measure 17 and 19 mm. in length. They agree very closely with the description of *carolina* presented (Part I, p. 150). This description was based on a specimen taken by Krombein in a trap nest at Kill Devil Hills, N.C., and some doubt was expressed as to its specific identity. Mr. Krombein writes that there was only one cell in this nest, so it was impossible to rear any adults from it; however, he has reared *carolina* from other trap nests with similar prey remains in that area.

Subfamily Nyssoninae

The following should be added to the subfamilial diagnosis presented in Part II, p. 36: spiracles with the peritreme well-defined, the walls of the atrium always lined with ridges which may or may not be spinose, the opening into the subatrium armed

with a circlet of spines except in *Alysson* and *Ochleroptera;* hypopharynx well developed, simple or bilobed, weakly to strongly spinulose, maxilla projecting as a free lobe, the inner margin rather long.

Alysson melleus Say (Plate XXIII, fig. 60)

The spiracles of this species were not previously described. These are of considerable interest since the opening between the atrium and subatrium is unarmed rather than fringed with spines as in most Nyssoninae (fig. 60). The hypopharynx of this species is a simple lobe bearing many subacute papillae.

Alysson cameroni Yasumatsu and Masuda

Professor K. Yasumatsu has recently brought to my attention a description of the head of the larva of this species which he and Masuda published in 1932 (Ann. Soc. Hist.-Nat. Fukuokensis, 1: 64). This species possesses six dark-tipped nipple-like protuberances on the front exactly as in *melleus.* Indeed, the head of this species is in every way similar to that of *melleus,* thus confirming the morphological uniqueness of this genus.

Nysson daeckei Viereck

The identification of this species remains tentative, as I have been unable to obtain further specimens or data. The spiracles of this species, not described earlier, closely resemble those of the following species. The hypopharynx is a simple lobe bearing subacute papillae on the sides, bare in the middle.

Nysson opulentus Gerstaeker (Plate XXI, figs. 36–38)

Body.—Length 7 mm.; maximum width 2.8 mm. As described and figured for *N. daeckei* (Part II, pp. 42–43, fig. 10), including similar callosities on the thoracic dorsum and similar transverse elevations on the abdominal segments. Integument without spinules or setae. Spiracles as shown in figure 37.

Head.—Width .87 mm.; height .82 mm. Front with three nipple-like, weakly pigmented prominences, especially prominent in lateral view (fig. 38). Coronal suture long; parietal bands absent; antennal papilla very short.

Mouthparts.—Labrum .4 mm. wide, its apical margin broadly truncate; surface strongly convex, with only some minute setigerous punctures laterally; epipharynx with strong, subacute papillae medially, laterally only

weakly papillose, the sensory areas well defined and lightly pigmented (fig. 36). Mandibles .48 mm. long, .2 mm. wide at the base, as described and figured for *daeckei*. Hypopharynx simple, bare in the middle and with subacute papillae on the sides. Maxillae and labium as described for *daeckei;* maxillary palpi 55 μ long; galeae 40 μ long; lacinial area strongly papillose; labial palpi 40 μ long; spinnerets measuring 50 μ from the base but not actually extending quite as far as the palpi.

Material.—A single specimen reared from a nest of *Psammaecius nebulosus* (Packard) at Ithaca, N.Y., July 24, 1956 (H. E. Evans).

Psammaecius costalis (Cresson)

(Plate XIX, fig. 39; plate XXIII, fig. 62)

Body.—Length 14 mm.; maximum width 4 mm. Form essentially as figured for *Gorytes canaliculatus* (Part II, fig. 17), including the blunt posterior end with the supra-anal lobe very slightly more prominent than the subanal; however, the pleural lobes are less prominent and more rounded, and the dorsal transverse elevations noted in *Gorytes* are not evident. Integument without spinules or setae; spiracles as figured for *Gorytes* (Part II, fig. 15) but the hexagonal cellules lining the walls of the atrium relatively larger; subatrium nearly as wide as the atrium, not at all constricted, not clearly differentiated from the trachea.

Head.—Width .76 mm.; height .8 mm. Much as figured for *Gorytes* (Part II, fig. 13); coronal suture strong; parietal bands and epistomal suture not visible; antennal orbits 70 μ in diameter, the papillae about 20 μ long; setae sparse and very short.

Mouthparts.—Labrum .38 mm. wide; apical margin with a deep median emargination; disc with about thirty-two punctures, most of which bear short setae, and with a submarginal row of about forty barrel-shaped sensilla (fig. 39). Epipharynx spinulose, each sensory area with about ten pores in an irregular longitudinal series. Mandibles .4 mm. long, .19 mm. wide at the base; base with five small setae laterally; apex with only two well-defined teeth (fig. 62). Maxillae and labium very much as figured for *Gorytes* (Part II, figs. 18, 20), the lacinial area with somewhat stronger spinules; maxillary palpi 75 μ long; galeae 60 μ long; labial palpi 55 μ long; spinnerets slightly exceeding the labial palpi.

Material.—One specimen from Kill Devil Hills, Dare Co., N.C., Aug. 4, 1958 (K. V. Krombein).

Psammaecius adornatus (Bradley) (Plate XXI, fig. 40)

Body.—Length 10 mm.; maximum width 3 mm. Essentially as described for the preceding species.

Head.—Width .75 mm.; height about the same. Coronal suture strong; parietal bands present but very weak; antennal orbits 60 μ in diameter, the papilla 18 μ long, arising from a slight elevation of the orbit.

Mouthparts.—Labrum .31 mm. wide; apex with a deep, V-shaped median emargination; disc papillose and rather strongly setose toward the apical margin; marginal sensory cones numbering about thirty-two; margin only rather weakly bristly (fig. 40). Epipharynx strongly spinulose. Mandibles .38 mm. long, .19 mm. wide at the base, about as figured for *costalis* but the five basal setae a little more widely scattered and the apical teeth more acute. Maxillary palpi large, 75 μ long; galeae more slender, 60 μ long; lacinial area with dense but short spinules. Oral surface of labium with strong papillae; labial palpi 60 μ long; spinnerets extending to about the length of the labial palpi.

Material.—One specimen from Mt. Diablo, Contra Costa Co., Calif., May 21, 1958 (J. Powell).

Ochleroptera bipunctata (Say)

The larva of this species was described from a single very small specimen, and there was some question in my mind as to whether it represented the last instar. I have recently collected three additional specimens of this species which I am sure are fully grown. These specimens vary in length from 6 to 8.5 mm. The body form is much as figured earlier (Part II, fig. 25), including the prominent supra-anal lobe and the dorsal thoracic callosities. The spiracles (not described earlier) are much as figured for *Alysson melleus* (fig. 60) except for a slightly wider subatrium; the opening between the atrium and subatrium is unarmed. Head width measures .62–.64 mm., nearly the same as in my earlier specimen. All the unusual features of the mouthparts also occur in these specimens and there are no appreciable differences in measurements of the various parts. The anterior lateral angles of the labrum are a bit more spinose than figured, and the epipharynx has a less orderly arrangement of spinules and papillae; the maxillae are more extensively papillose than figured, and some of the papillae along the inner margin are acute apically.

Material.—Three larvae from a sand bank at Six-mile Creek, Ithaca, N. Y., August 1958 (H. E. Evans).

Bembecinus godmani godmani (Cameron) (Plate XXIV, figs. 71–73)

Body.—Length 14 mm.; maximum width 4 mm. Essentially as figured for *B. neglectus* (Part II. fig. 39). Integument without spines or setae. Spiracles with the walls of the atrium divided into irregular hexagons;

opening into subatrium armed with a circlet of simple spines; subatrium not clearly separated from the trachea.

Head.—Width .78 mm.; height .76 mm. Coronal suture strong; parietal bands indicated by weak lines; antennal orbits circular, 65 μ in diameter, the papillae only about 20 μ long. Setae sparse and small, the longest ones measuring about 15 μ.

Mouthparts.—Labrum .34 mm. wide, its apex very weakly emarginate; disc with about twenty setae, the apical margin with about fourteen sensory cones; epipharynx with several sensory cones and with numerous spinules which grade into papillae on certain parts (fig. 71). Mandibles .41 mm. long, .19 mm. in maximum width; base with two short setae; apex acute, the inner margin with two teeth which are close together, each in a slightly different plane (fig. 73). Maxillae with the palpi stout, 70 μ long; galeae more slender, 45 μ long; lacinial area with strong papillae which grade into spinules basad (fig. 72). Labial palpi 55 μ long; spinnerets very short, shorter than the labial palpi.

Material.—Four specimens from Austin, Texas, May 30, 1958 (C. S. Lin).

Stictia vivida (Handlirsch)

Body.—Length 38 mm.; maximum width 9.5 mm. Form as described and figured for *S. carolina* (Part II, p. 53, fig. 73); body setae equally abundant and conspicuous. Spiracles with the peritreme very narrow, the orifice very large; walls of the atrium lined with concentric rows of spinules.

Head.—Width 2.1 mm.; height 2.0 mm. Coronal suture long and distinct; parietal bands arched, about .4 mm. long; brown spots on front and clypeus as in *carolina*, but a little more extensive. Antennal orbits circular, 110 μ in diameter; antennae very short, 45 μ long and 25 μ in maximum thickness.

Mouthparts.—Labrum .8 mm. wide; features of labrum and epipharynx not differing notably from *carolina;* margin of labrum with about forty prominent, pigmented sensilla; each sensory area of epipharynx with about ten large pores with thick, pigmented rims. Mandibles shaped as in *carolina*, but the base with only four punctures which do not bear detectable setae in the specimens available. Hypopharynx prominent, truncate apically, surface weakly biconvex, clothed with long spinules. Maxillae extensively spinulose; palpi and galeae both about 120 μ long, the latter considerably more slender and tapering. Labial palpi 95 μ long, slightly exceeded by the spinnerets, which are truncate apically; oral surface of labium with long spinules basally.

Material.—Two specimens from Boca Chica, Cameron Co., Texas, June 26, 1956 (H. E. Evans & E. G. Matthews). (See Evans, 1957, Ent. News, 68: 76–77.)

Genus **BEMBIX** Fabricius

Since completing Part II I have collected many more larvae of this genus, including representatives of three species not previously seen. I am still unable to present a key which will separate the larvae of all known species of this genus, but it happens that the species which key out together in the following key are isolated from one another either geographically or ecologically so identification should be possible on that basis. (For a summary of geographical and ecological factors, see Evans, 1957, Studies on the Comparative Ethology of Digger Wasps of the Genus *Bembix,* Cornell Univ. Press, p. 202.)

Key To Full-grown Larvae Of Twelve Species Of Bembix

1. Galeae much more slender and not longer than the maxillary palpi, terminating in two minute sensilla 2
   Galeae larger and longer than the maxillary palpi, terminating in several minute sensilla 7
2. Body setae abundant and fairly conspicuous; head with numerous setae, including some on the front above the antennal orbits.
   pruinosa Fox, *occidentalis* Fox
   Body setae sparse and very inconspicuous; front without noticeable setae above the antennal orbits 3
3. Epipharyngeal sensory areas connected by a pigmented band 4
   Epipharyngeal sensory areas connected by a smooth band which is not or barely pigmented 5
4. Body setae extremely minute and few in number; parietal bands barely visible, without a dark spot ..... *u-scripta* Fox
   Body setae somewhat more numerous and noticeable; parietal bands distinct, with a dark spot at the upper end of each ... *belfragei* Cresson
5. Smaller species, the head capsule 1.55–1.65 mm. in width.
   spinolae Lepeletier, *comata* Parker, *hinei* Parker, *cinerea* Handlirsch
   Larger species, the head capsule 1.75–1.8 mm. in width 6
6. Antennae slightly longer than half the diameter of the orbit; emargination of labrum rather strong ..... *nubilipennis* Cresson
   Antennae slightly shorter than half the diameter of the orbit; emargination of labrum weak ..... *sayi* Cresson
7. Anterior tentorial arms reaching to a point opposite the middle of the antennal orbits ..... *troglodytes* Handlirsch
   Anterior tentorial arms reaching to a point opposite the lower margin of the orbits ..... *texana* Cresson

Bembix u-scripta Fox [3] (Plate XXI, fig. 41; plate XXIII, fig. 63)

Body.—Length 25 mm. Thoracic dorsum and pleural lobes with a few setae, but these are extremely short and inconspicuous, about as in *Steniolia* and *Stictiella*.

Head.—Width 1.6 mm.; height 1.5 mm.; with a prominent brown spot below and mesad of each antennal orbit; coronal suture strong; parietal bands weak, scarcely visible. Antennal orbits circular, 110 μ in diameter; antennae 40 μ long. Setae very minute.

Mouthparts.—Labrum .65 mm. wide; apical margin weakly emarginate, with about 24 pigmented, barrel-shaped sensilla; epipharynx with the sensory areas pigmented and connected by a pigmented band, the lateral portions weakly pigmented and bearing papillae and weak spines (fig. 41). Mandibles with three teeth, the basal one weak, and with a faint indication of an additional tooth between the apical two (fig. 63). Hypopharynx prominently biconvex, strongly spinulose. Maxillary palpi 100 μ long; galeae 90 μ long; lacinial area with dense, flexible spinules. Labial palpi 80 μ long; spinnerets blunt, a little shorter than the palpi.

Material.—Three specimens from Port Isabel, Cameron Co., Texas, June 23–27, 1956 (H. E. Evans).

Bembix nubilipennis Cresson (Plate XXI, fig. 42)

Body.—Length 32 mm. Setae on dorsum and pleural lobes inconspicuous, but longer and more numerous than in *u-scripta*.

Head.—Width 1.8 mm.; height 1.6 mm.; front and clypeus each with a pair of small dark spots near the midline, the front also with larger dark spots beneath and mesad of the antennal orbits; parietal bands long, unpigmented; antennal orbits 110 μ in diameter; antennae 65 μ long; setae extremely small.

Mouthparts.—Labrum .68 mm. wide; apical margin strongly emarginate and with about thirty strong sensilla; epipharynx with the space between the sensory areas bare but not pigmented, the sides with a prominent pigmented band, weakly papillose and spinulose (fig. 42). Mandibles with two weak teeth along the inner margin in addition to the apical tooth. Hypopharynx broad, truncate apically, strongly spinulose. Maxillary palpi and galeae both about 100 μ in length, the latter more slender and tapering than the former. Labial palpi 80 μ in length, the spinnerets blunt, about as long as the palpi.

Material.—Nine specimens from Versailles, Indiana, July 16–23, 1957 (H. E. Evans).

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[3] At any rate, this is the species which I elsewhere discussed under this name (*op. cit.*, pp. 104–108). The males actually key to *arcuata* Parker and the females are intermediate in color between *arcuata* and *u-scripta*. I have examined the type specimens of both these species and am not convinced that the genitalic differences are as pronounced as Parker claims (1917, Proc. U. S. Nat. Mus., 52: 82). I am tentatively considering the two names synonyms.

Bembix hinei Parker

Body.—Length 28 mm.; setae as in the preceding species.

Head.—Width 1.6 mm.; height 1.46 mm.; brown spot below and mesad of the antennal orbits very conspicuous; orbits 80 μ in diameter; antennae very short, 30 μ in length; setae all very minute.

Mouthparts.—Labrum .6 mm. wide; apical margin weakly concave, with about thirty strong sensilla; epipharynx as in *nubilipennis*. Inner margin of mandibles with two strong teeth and two weaker teeth, about as in *u-scripta*. Maxillary palpi 120 μ long; galeae 100 μ long; labial palpi 70 μ long, slightly exceeded by the spinnerets.

Material.—Four specimens from 17 miles west of Sabine Pass, Texas, June 10–12, 1956 (H. E. Evans).

Subfamily Philanthinae

The following should be added to the subfamilial diagnosis presented in Part III, pp. 79–80: maxillae projecting as large, free lobes; hypopharynx relatively small, simple, with spinules or papillae, in *Cerceris* remarkably small, strongly bilobed, strongly spinulose; prementum of labium broader than long, sometimes nearly twice as broad as long.

Cerceris fumipennis Say

I have recently collected four additional larvae of this species at Versailles, Ind., July 16–23, 1957. Fully extended specimens measure about 21 mm. in length, but the measurements of head parts agree closely with those presented for the specimen from Arkansas, which was less elongate. The bare areas on the pleural lobes and sides of the dorsum are present but not at all elevated or conspicuous.

Cerceris robertsonii Fox

Two additional larvae of this species, collected at Ithaca, N.Y., Aug. 12, 1958, agree in most particulars with the description presented earlier (Part III, p. 86). However, the dorsal and lateral smooth areas are not at all elevated and welt-like. It is probable that differences such as this are caused by differences in the type of preservative used or in the state of the larva at the time of preservation.

It is now apparent to me that the larva described as that of *C.*

nigrescens Smith (Part III, pp. 85–86, figs. 27–29) is actually that of *robertsonii*. No adult was collected in association with the nest from which this larva was taken, but a female *nigrescens* was taken nearby and assumed to belong to the nest. The cells of this nest contained the chrysomelid beetle *Rhabdopterus picipes* Oliv., as did the cells of the nest containing the two larvae mentioned above—in the latter case with an associated adult *robertsonii*. *C. robertsonii* is recorded as preying upon this same species of beetle in North Carolina (Krombein, 1952, Wasmann Jour. Biol., 10: 288–294), while *nigrescens* is reputed to prey upon weevils. It will be noted that the differences pointed out between *robertsonii* and the supposed *nigrescens* were of a very minor nature.

Subfamily Trypoxyloninae

In this subfamily the hypopharynx is large, not bilobed, and weakly to strongly spinulose; the integument is without spinules dorsally and may or may not have some inconspicuous spinules on parts of the venter. At this time I am able to add to my discussion of the genus *Trypoxylon* in Part III, and also to describe for the first time the larva of *Pisonopsis*. The latter genus has often been included in the subfamily Larrinae, but the larvae (as well as the nesting behavior) suggest that it is more properly placed here. Although the larva is very similar to that of *Pison*, it does possess certain characters suggestive of the Larrinae: the body and head setae are unusually strong, the prothorax bears an extra pair of small lobes, and the lacinial lobe is situated closer to the apex than in other Trypoxyloninae.

Pisonopsis birkmanni Rohwer (Plate XXIV, figs. 64–70)

Body (diapausing larva).—Length about 5 mm.; maximum width 1.8 mm. Pleural lobes prominent, especially those on the thorax, the prothorax with an extra pair of small lobes dorsad of the pleural lobes (much as in *Solierella*, Part IV, fig. 42). Integument without spinules, but all body segments except the last with a transverse series of setae on the dorsum; on the prothorax there are eighteen setae forming an irregular double row, the setae being about 80 μ in length (fig. 70). Spiracles small; atrium lined with ridges which form large, irregular polygons; opening into subatrium small, simple; subatrium elongate (fig. 65).

Head.—Width .8 mm.; height .61 mm. (fig. 64). Parietal bands absent; epistomal suture distinct; coronal suture very short. Antennal orbits ovoid, 55 μ in maximum diameter, with a circular central area which is lightly pigmented (fig. 67). Setae very large, up to 70 μ in length; there are about thirty setae on the head capsule and six more on the clypeus.

Mouthparts.—Labrum .3 mm. wide, .14 mm. high; apical margin weakly concave, with six setae set in the concavity, but the margin without bristles; disc with twelve setae besides the marginal group, also with a few weak sensilla near the margin (fig. 69). Epipharynx with strong spinules, except more or less bare medio-apically. Mandibles .32 mm. long, .18 mm. wide at the base; sides with a single large seta; apex with five teeth which tend to surround a ventral concavity (fig. 66). Maxillae somewhat papillose apically, with several large lateral setae; palpi 60 μ long, galeae 50 μ long; lacinial area with an angular lobe which arises from the base, the lobe bearing a series of very heavy spines (fig. 68). Labium with the palpi 40 μ long, the spinnerets in the available material somewhat degenerate, but apparently short and somewhat acute apically; oral surface of labium with some strong spinules, the apex and ventral surface with several large setae.

Material.—Two specimens removed from cocoons in stems of salsify, collected by F. X. Williams at La Mesa, San Diego Co., Calif., October 1958.

Genus **TRYPOXYLON** Latreille
Subgenus **Trypargilum** Richards

Since the publication of Part III, Karl V. Krombein has sent me many additional larvae of this subgenus, all taken in trap nests. The availability of longer series of several species makes it possible to re-evaluate some of the characters of systematic value. In general, the species of this subgenus are exceedingly similar, and some of the characters which I previously stressed now seem to me none too reliable. Width of the head capsule seems to vary relatively little intraspecifically and is therefore of some value in separating species.

The following key to some species of this subgenus is, I believe, more reliable than that presented earlier (Part III, pp. 90–91), but it is still far from satisfactory. Two species, *collinum* Smith and *texense* Saussure, have been added. However, I have omitted two western species, *spinosum* Cameron and *arizonense* Fox. I have seen no additional material of these species and the material I have is poorly preserved. My present feeling is that the emargination of the labrum noted in these two species may

be partially due to shrinkage of the specimens. Both species will run to the first half of couplet 4 of the present key.

Key To Full-grown Larvae Of Eastern Species Of Trypargilum

1. Epipharynx with the spinules extending to the apical margin medially or very nearly so; larger species, width of head capsule from 1.5 to 2.3 mm. 2
   Epipharynx with an area medio-apically which is devoid of spinules; generally smaller species, width of head capsule from 1.0 to 1.62 mm. .. 3
2. Width of head capsule 2.0–2.3 mm.; labrum with 18–20 setae on the disc. *politum* Say
   Width of head capsule 1.5–1.8 mm.; labrum with 12–16 setae on the disc. *striatum* Provancher
3. Species of small size, the head capsule from 1.0 to 1.15 mm. wide; labrum weakly, evenly concave apically, without evidence of division into lobes ..... *collinum* Smith, *rubro-cinctum* Packard
   Species of moderate size, the head capsule from 1.16 to 1.62 mm. wide .. 4
4. Head capsule from 1.16 to 1.45 mm. wide; venter weakly spinulose. *clavatum* Say, *tridentatum* Packard
   Head capsule from 1.40 to 1.62 mm. wide; venter rather strongly spinulose 5
5. Width of head capsule from 1.40 to 1.55 mm. (ave. 1.45); antennal orbits not or barely pigmented ..... *johannis* Richards
   Width of head capsule from 1.56 to 1.62 mm. (ave. 1.59); antennal orbits lightly pigmented, brownish ..... *texense* Saussure

Trypoxylon (Trypargilum) texense Saussure

Body.—Length 21 mm.; maximum width 5.5 mm. Form very much as figured for *clavatum* (Part III, fig. 39) but slightly more swollen posteriorly. Thoracic dorsum with a few fairly prominent setae; integument smooth dorsally, rather strongly spinulose ventrally.

Head.—Width 1.56–1.62 mm. (ave. 1.59); height 1.45–1.48 mm. Parietal bands weakly pigmented, about .2 mm. long; antennal orbits lightly pigmented, transversely ovoid, 75 μ in diameter. Longest setae 75 μ in length.

Mouthparts.—Labrum .56 mm. wide; apical margin with well-defined lateral lobes; disc with ten to fourteen setae, apical margin also with six to eight setae near the midline. Epipharynx spinulose except medio-apically, where it is bare; each side with six conical sensilla. Mandibles .6 mm. long, .36 mm. in maximum width, of the usual form of the genus. Maxillary palpi 60 μ long; galeae slender, 30 μ long; lacinial lobe large and acute, with the spinules moderately strong. Labial palpi 60 μ long; spinnerets protruding slightly beyond the palpi.

Material.—Three specimens taken from old *Sceliphron* nests beneath a bridge, near Port Isabel, Cameron Co., Texas, May 10, 1958 (H. E. Evans & O. S. Flint).

Trypoxylon (Trypargilum) collinum Smith

Body.—Length 12 mm.; maximum width 3 mm. Form very much as in *clavatum;* spiracles also as in that species.

Head.—Width 1.13 mm.; height 1.06 mm. Parietal bands weak, .22 mm. long. Antennal orbits nearly circular, 60 μ in diameter. Longest head setae 55 μ in length.

Mouthparts.—Labrum .42 mm. wide; disc with twelve setae; apical margin weakly concave medially, with a group of about twelve setae set in the emargination. Epipharynx spinulose except medio-apically, where it is bare. Mandibles as described for *clavatum.* Lacinial lobe very weakly spinulose, the maxillae elsewhere weakly papillose; palpi 50 μ long, galeae slender, 35 μ long. Labial palpi 48 μ long, considerably exceeded by the spinnerets.

Material.—One specimen from Lake Placid, Florida, July 10, 1957 (K. V. Krombein).

Trypoxylon (Trypargilum) clavatum Say

In the sixteen specimens of this species now before me, the width of the head varies from 1.16 to 1.45 mm. with a mean of 1.30. The number of setae on the disc of the labrum varies from eight to fourteen, but the usual number is ten, less commonly twelve. The trilobed condition of the labrum is not always as distinct as shown in my figure (Part III, fig. 41), and often the median truncate lobe is broader than this.

Material.—Fourteen specimens from Plummers Island, Maryland, July–Sept. 1956–57 (K. V. Krombein); one from Derby, N.Y., Aug. 1954 (K. V. Krombein); one from Ithaca, N.Y., Aug. 1955 (H. E. Evans).

Trypoxylon (Trypargilum) johannis Richards

In the four specimens of this species now before me, the width of the head varies from 1.40 to 1.55 mm. with a mean of 1.45. The number of setae on the disc of the labrum varies from ten to fourteen. The integument is rather heavily spinulose ventrally, and the spinules extend up the sides of the thorax to a somewhat greater extent than in other species.

Material.—Three specimens from Lake Placid, Florida, Apr.–June 1957 (K. V. Krombein); one specimen from Welaka, Fla., May 1955 (H. E. Evans).

Trypoxylon (Trypargilum) tridentatum Packard

In the five specimens of this species now before me, the width of the head varies from 1.25 to 1.35 with a mean of 1.30. The usual number of setae on the disc of the labrum is twelve, but one specimen has sixteen. Most specimens show little evidence of three lobes on the labrum, and the median portion is more inclined to be concave than in *clavatum*. However, I am unable to separate the larvae of *clavatum* and *tridentatum* with any degree of certainty.

Material.—Four specimens from Kill Devil Hills, Dare Co., North Carolina, Aug.–Sept. 1956; one specimen from 4 mi. W. of Cabin John, Maryland, Aug. 1955 (all K. V. Krombein).

Trypoxylon (Trypargilum) rubro-cinctum Packard

In the nine specimens of this species now before me, the head width varies from 1.03 to 1.15 mm. with a mean of 1.08. The head width of 1.27 mm. given previously (Part III, p. 94) was in error. The number of setae on the disc of the labrum varies from eight to twelve, with most specimens having ten. The apex of the labrum is gently concave with no evidence of lobes.

Material.—Seven specimens from Plummers Island, Maryland, July 1956–57; two specimens from Kill Devil Hills, Dare Co., North Carolina, Aug.-Sept. 1956 (all K. V. Krombein).

Trypoxylon (Trypargilum) striatum Provancher

In the sixteen specimens of this species now before me, head width varies from 1.51 to 1.81 mm. with a mean of 1.65. The number of setae on the disc of the labrum varies from twelve to sixteen, with fourteen the most common number. The spinules on the epipharynx extend nearly to the apical margin medially.

Material.—Fourteen specimens from Plummers Island, Maryland, July–Sept. 1956–57; two specimens from 4 mi. W. of Cabin John, Maryland, Aug. 1955 (all K. V. Krombein).

Trypoxylon (Trypargilum) politum Say

I have seen no additional specimens of this species, but it may be of interest to record that in the twenty-six available specimens, head width varies from 2.0 to 2.3 mm. with a mean of 2.19 mm.

Subfamily Crabroninae

In this subfamily the hypopharynx is small, subhemispherical, and spinulose. Since completing Part III I have obtained larvae of three species of *Crabro* and one *Lindenius*. I have also examined additional specimens of *Ectemnius stirpicolus*, as well as specimens of an unknown *Ectemnius* and an unknown *Crossocerus*. The larvae of the latter two genera agree closely with the descriptions I have presented, but those of *Crabro* and *Lindenius* necessitate modifications of my table of generic characters (Part III, pp. 101–102). A revised key to the genera of all known sphecid larvae is presented on a later page.

Lindenius tylotis Court and Bohart (Plate XXII, figs. 51–53)

The larva of this species is similar in most details to that of *L. pygmaeus* as described by Grandi (see Part III, p. 103). However, the mandibles have four distinct teeth rather than three, and the species will therefore not run to *Lindenius* in my table. Possibly the very short galeae, which are less than a third the length of the maxillary palpi in both *pygmaeus* and *tylotis*, will serve to separate *Lindenius* from related genera.

Body.—Length 6.5 mm.; maximum width 1.7 mm. Fusiform, somewhat thickened posteriorly; anal segment forming a rounded lobe; pleural lobes rounded, those on the thorax more prominent than those on the abdomen; each body segment with a transverse elevation dorsally about midway, interrupted on the mid-dorsal line and extending laterally nearly to the pleural lobes. Integument apparently smooth, but under high magnification scattered minute spinules can be seen on the venter; body setae very sparse and inconspicuous. Spiracles with the atrium lined with weak ridges, the subatrium elongate and more or less parallel-sided.

Head.—Very slightly wider than high; width .76 mm.; height .73 mm. Coronal and epistomal sutures weak; parietal bands absent. Antennal orbits circular, 35 μ in diameter. Head with numerous (about forty) setae, most of them in a single irregular series on the sides of the head, the longest ones 35 μ in length.

Mouthparts.—Labrum .26 mm. wide, .12 mm. high; apical margin truncate, strongly bristly; disc with about twenty setae and a row of minute subapical sensory cones (fig. 53). Epipharynx strongly spinulose, especially medially. Mandibles .18 mm. in maximum width, .36 mm. long; inner margin with four distinct teeth, all in about the same plane (fig. 51). Maxillae setose laterally, strongly spinulose medially; palpi 50 μ long; galeae unusually small, only about 15 μ long. Hypopharynx a broad, spinulose lobe. Labium spinulose on the oral surface; palpi short, slightly

exceeded by the spinnerets, which are blunt apically.

Material.—Two specimens from Davis, Calif., July 2, 1957 (H. K. Court & R. M. Bohart).

Genus **CRABRO** Fabricius

My interpretation of this genus in Part III was based on a single poorly preserved specimen and I was unable to separate the genus from *Crossocerus*. I now have eighteen well preserved specimens representing three species. The genus appears to be readily separable from *Crossocerus:* the body is somewhat stouter; the integument is strongly spinulose ventrally, the spinules elongate and separated by about their own length; the subatria of the spiracles are broadly expanded; and the mandibles are excavated apically on the ventral surface, with a weak fifth tooth situated near the base of the excavation.

Crabro (Crabro) monticola (Packard) (Plate XXII, figs. 43–46)

Body.—Length 15 mm.; maximum width 5 mm. (fig. 46). Stout, grub-like; pleural lobes large, rounded, and somewhat protuberant, especially those on the thorax; prothorax also somewhat lobe-like on each side of the dorsum and with a pair of smaller lobes in front of the spiracles; dorsum of each segment with a transverse swelling posteriorly; anal segment slightly produced, its apex narrowly rounded. Body setae virtually absent; integument spinulose ventrally and on parts of the sides and dorsum (fig. 44). Spiracles with the atrium lined with irregular hexagons, the subatrium rather irregularly swollen (much as figured for *argus*, fig. 49).

Head.—Width 1.42 mm.; height 1.25 mm. (fig. 43). Parietal bands short and rather wide, about .3 mm. long; epistomal suture distinct; antennal orbits with heavily pigmented rims, measuring 60 μ in diameter. Anterior tentorial arms, hypostomal thickenings, and a pair of spots ventrad of the occipital foramen, brown. Head setae largely confined to the top and sides, the longest ones measuring about 30 μ.

Mouthparts.—Labrum .44 mm. wide, its apical margin bristly, weakly emarginate medially; disc with about twenty-five setae (fig. 45). Epipharynx strongly spinulose, especially medially; sensory areas containing three conical sensilla plus several pores basad of these. Mandibles .63 mm. long, .33 mm. wide, heavily pigmented, with a weak basal seta; apex with four teeth, the penultimate rather weak, the ventral side somewhat excavated between the first and fourth teeth, the excavated portion bearing a very weak fifth tooth (as in fig. 47). Maxillae with the palpi stout, 70 μ long; galeae more slender, 40 μ long; lacinial area with an abundance of long, somewhat flexible spinules. Labial palpi 65 μ long, the spinnerets extending to about twice this length; oral surface of prementum densely spinulose.

Material.—Nine specimens from North Haven, Conn., June 28, 1958 (H. E. Evans).

Crabro (Synothyreopus) advenus Smith (Plate XXII, figs. 47, 48)

This species was previously described from a single larva in which the body was poorly preserved and the mandibles somewhat worn (Part III, p. 104). I have since obtained a series of well preserved larvae and am able to add a few notes and make a few corrections to my earlier description.

Body.—Length 12 mm.; maximum width 3.5 mm. Form very similar to that of the preceding species, including the prominent convexities on the anterior segments. Body setae virtually absent; integument weakly spinulose ventrally. Spiracles as in *argus* (fig. 49).

Head and mouthparts.—As previously described in all respects, including measurements, except as follows. Mandibles .53 mm. long, .28 mm. in maximum width; inner margin with four teeth, somewhat excavated ventrally and with some evidence of a fifth, weak tooth at the base of the excavation (fig. 47). Maxillae somewhat papillose apically; apex of labium with an extensive covering of spinules above, below with a few papillae and eight setae (fig. 48).

Material.—Six specimens from South Hill, Ithaca, N.Y., July 13, 1958 (H. E. Evans).

Crabro (Norumbega) argus (Packard) (Plate XXII, figs. 49, 50)

Body.—Length 11 mm.; maximum width 3.5 mm. Form very much as described and figured for *monticola;* setae relatively numerous, but very short and inconspicuous, on the thoracic dorsum; spinules relatively abundant and conspicuous ventrally and on the ventral prothoracic lobes. Spiracles as shown in fig. 49.

Head.—Width 1.05 mm.; height .9 mm. Parietal bands very weak, unpigmented; longest head setae 25 μ long; antennal orbits 60 μ in diameter. In all other respects as described and figured for *monticola.*

Mouthparts.—Labrum .33 mm. wide, the anterior half with numerous setae, the margin truncate, bristly, some of the spinules extending onto the upper surface medially (fig. 50). Epipharynx with very strong spinules, especially on the middle third; each side with about nine sensory pores in an irregular longitudinal row. Mandibles .49 mm. long, .26 mm. in maximum width, much as figured for *advenus,* but the ventral excavation somewhat weaker and with very little indication of a fifth tooth. Features of maxillae and labium also much as figured for *advenus;* maxillary palpi 65 μ long; galeae 35 μ long; labial palpi 40 μ long; spinnerets extending to slightly more than twice the length of the labial palpi.

Material.—Three specimens from a sand-bank at Six-mile Creek, Ithaca, N.Y., July–August 1958 (H. E. Evans).

Crossocerus fergusoni Pate (Plate XXIII, fig. 61)

On examining further specimens of this species I find that the spiracular subatrium generally has a small, globular expansion as shown in figure 61. The mandibles have a very slight ventral excavation apically, but this is much less distinct than in *Crabro* and *Ectemnius*.

Ectemnius stirpicolus (Packard)

During the preparation of Part III, I had available only diapausing larvae of this species. I have since received two non-diapausing specimens from Dunn Loring, Va., August 1958 (K. V. Krombein). The body is slightly more cylindrical than in *Crabro,* and the prothoracic convexities are less prominent. The labrum has a series of ten small sensory cones near the apical margin, not noted or figured previously. Otherwise there is close agreement with my description and figures (Part III, p. 109, figs. 85–90).

Larvae of *Ectemnius* closely resemble those of the genus *Crabro.* The differences in body form and in the form of the spiracles are rather subtle. In all specimens of the genus *Ectemnius* which I have seen, the four major mandibular teeth are very strong and acute, the ventral excavation is large, and the fifth, ventral tooth is strong. Also, in all specimens of *Ectemnius* I have seen, the galeae are about two thirds the length of the maxillary palpi and subequal in length to the labial palpi; in *Crabro* the galeae tend to be shorter, not much over half the length of the maxillary palpi and distinctly shorter than the labial palpi.

Subfamily Astatinae

Astata bicolor Say

Body.—Length 9 mm.; maximum width 2.4 mm. Form much as illustrated for *A. unicolor* (Part IV, fig. 1); abdominal segments 2–4, but especially 4, prominently humped dorsally.

Head.—Very much wider than high; width 1.4 mm.; height .85 mm. Features of head much as in *unicolor;* parietal bands .4 mm. long; head

setae distributed as in *unicolor*, the longest ones 40 μ long. Antennal orbits circular, 90 μ in diameter; antennal papillae very short, 25 μ long and nearly as thick.

Mouthparts.—Labrum .43 mm. wide; details very much as figured for *unicolor* except the sensilla at the margin less well defined. Epipharynx clothed with small spinules on the sides, the median area barely spinulose; sensory pores weak, about six on each side of the midline. Mandibles .5 mm. long, .35 mm. in maximum width; sides with about six strong setae; apex with four large, blunt teeth, arranged as in *unicolor*. Maxillae and labium very much as figured for *unicolor;* maxillary palpi 70 μ long; galeae more slender, 50 μ long; labial palpi 50 μ long; spinnerets protruding slightly farther than the labial palpi.

Material.—Three specimens from the beach of Laguna Madre, near Port Isabel, Cameron Co., Texas, May 10, 1957 (H. E. Evans).

Subfamily Larrinae

In this subfamily the hypopharynx is roughly semicircular and is densely clothed with spinules. In presenting a table of tribal and generic characters in Part IV, I expressed doubt that the characters used for separating the Miscophini and Larrini would hold when more genera of Miscophini had been studied. As a matter of fact, the larva of *Plenoculus*, described below for the first time, forms an exception to all of the characters of the Miscophini which I listed, leaving me quite unable to separate these two tribes on larval characters. Characters for separating *Plenoculus* from other known Larrinae are presented in the key to genera on a later page.

Plenoculus davisi Fox (Plate XXIII, figs. 54–59)

Body.—Length 7 mm.; maximum width 2 mm. (fig. 56). Grub-like, distinctly thicker toward the posterior end of the body than anteriorly; prothorax with a single pair of small but very prominent, conical pleural lobes; pleural lobes of metathorax and first abdominal segment weakly conical, those of the remainder of the body rounded, including a pair of rather large, low lobes on abdominal segment nine. Anal segment small, rounded. A few inconspicuous setae are present on the dorsum, venter, and pleural lobes of the anterior segments; the dorsum of each segment bears sparse, strong spinules both anteriorly and posteriorly (but not in the center), but these spinules appear to be absent from the sides and venter. Spiracles small and inconspicuous; atrium lined with a few weak ridges; subatrium elongate, gradually expanded and then abruptly constricted (fig. 55).

Head.—Width .73 mm.; height .60 mm. (fig. 54). Coronal suture weak; parietal bands very weak, unpigmented; setae prominent, the longest ones measuring 45 μ; antennal orbits circular, 45 μ in diameter.

Mouthparts.—Labrum .3 mm. wide, bearing about twenty setae, the apical margin weakly bristly, with a series of small sensilla, not emarginate medially (fig. 58). Epipharynx with a group of strong spinules near the base medially, elsewhere with smaller spinules; sensory areas each containing eight nipple-like sensilla. Mandibles .34 mm. long, .16 mm. in maximum width; base with a single seta; apex with four teeth in about the same plane, plus a fifth tooth located beneath the basal two and associated with a weak ventral concavity (fig. 59). Maxillae papillose apically, the lacinial area weakly produced and armed with small spinules; palpi 50 μ long; galeae very small, about 10 μ long. Apical portion of labium nearly spherical; palpi 40 μ long; spinnerets truncate, about 60 μ long; oral surface with two patches of long spinules, papillose laterally (fig. 57).

Material.—One specimen reared from an egg collected at Granby Center, Oswego Co., N.Y., Aug. 20, 1958 (H. E. Evans).

Subfamily Pemphredoninae, Tribe Pemphredonini

In this group the hypopharynx is very small and not easily seen; apparently it is without spinules. In Part IV I pointed out that the larva of *Ammoplanus* is very different from that of other known Pemphredonini. It is now apparent that the larva of *Spilomena* goes with that of *Ammoplanus*. Pate (1937, Trans. Amer. Ent. Soc., 63: 94) remarks that "*Ammoplanus* and its more closely related groups may have had their origin in a Spilomenoid ancestor".

Passaloecus mandibularis (Cresson)

One additional specimen of this species (from Derby, N.Y., Sept. 6, 1957, L. H. Krombein) agrees closely with my description (Part IV, pp. 131–132) except that the median pigmented band on the labrum is complete, reaching the base. I have re-examined the Ithaca series and find that in two of the specimens this band is also complete, rather than abbreviated as figured. Apparently the length of this band varies intraspecifically.

Spilomena vagans Blüthgen

Valkeila (1957, Ann. Ent. Fennici, 23: 176) has very recently provided a brief description of the larva of this species. The body shape is not dissimilar to that of *Pemphredon*. The head

is slightly broader than high; setae are apparently absent from both head and body; distinct and fairly long antennal papillae are present. The labrum is somewhat semicircular, with no apical emargination; the mandibles have three sharp teeth; the galeae are present only as minute knobs; the spinnerets are acute and extend much beyond the labial palpi.

Spilomena enslini Blüthgen

As Valkeila points out in his discussion of *S. vagans,* Enslin provided a brief description of the larva of this species in 1922 (Arch. Naturgesch., vol. 88, Abt. A, heft 5, p. 135) under the name *troglodytes* Van der Linden. As in *vagans,* the body form is not unlike that of *Pemphredon;* the dorsal profile is somewhat serrate, the integument smooth. The head is wider than high and possesses antennal papillae of moderate length but apparently no setae. The labrum is evenly arcuate apically; the mandibles have three sharp teeth; the spinnerets are acute and slightly exceed the labial palpi; the galeae are not described or included in the figure, presumably being too small to be readily visible.

Table of Subfamily Characters

A. Apex of labium very broad, the spinneret a long transverse slit with prominently raised lips; mandibles bearing several nonsetigerous punctures near the base laterally; maxillae more or less directed mesad apically, the inner margin short; galeae as large as or larger than the maxillary palpi; antennal papillae absent, the antennal sensilla arising from the membrane of the orbits; parietal bands strong; anus terminal ..... SPHECINAE (Part I)

AA. Apex of labium more narrow, the spinnerets paired, each opening at the end of a short or fairly long process; mandibles bearing one or more setae near the base laterally (except Mellininae); galeae smaller (i.e., shorter and/or more slender) than the maxillary palpi (a very few exceptions in the Nyssoninae).

B. Anus directed caudad and situated at the apex of the abdomen or very nearly so (slightly preapical in the Psenini); antennal papillae present (except absent in most Pemphredonini).

C. Maxillae with the apex directed somewhat mesad and closely associated with the labium and hypopharynx; epipharynx often spinulose laterally, but the spinules not or barely reaching the midline.

D. Mandibles with a weakly pigmented area near the base laterally, this area bearing a considerable number of setae; fourth abdominal segment strongly humped dorsally; parietal bands strong; epipharynx strongly spinulose on the sides ..... ASTATINAE (Part IV)

DD. Mandibles with a single seta near the base laterally; fourth abdominal segment no more humped than any other; parietal bands absent or very weak; epipharynx rather weakly spinulose antero-laterally.

PEMPHREDONINAE (Pemphredonini, Part IV; Psenini, Part V)

CC. Maxillae projecting apically as lobes which are free from the labium and hypopharynx; epipharynx spinulose (rarely papillose) over much of its surface; antennal papillae always present.

D. Integument smooth or very inconspicuously spinulose; opening between atria and subatria of spiracles armed with a circlet of spines (except in *Alysson* and *Ochleroptera*); apical abdominal segment simple; galeae fairly strong, at least half as long as the maxillary palpi, sometimes as long as or longer than the palpi ..... NYSSONINAE (Part II)

DD. Integument clothed nearly everywhere with dense, small spinules; opening between atria and subatria simple, unarmed; posterior end of the body modified for locomotion, either the supra-anal or the subanal lobe protuberant, or the two lobes together forming a tubular process; galeae much smaller than the maxillary palpi.

PHILANTHINAE (Part III)

BB. Anus directed ventrad and situated well before the apex of the abdomen, the anal segment forming a rounded or conical lobe beyond the anus; antennal papillae absent, the sensilla arising from the membrane of the orbits.

C. Body with pleural lobes and a series of dorso-lateral prominences conically produced, dark-tipped, and armed with a series of short, stout spinules; mandibles without setae, on the inner margin with a strong concavity beyond which there are two teeth connected by a blade-like portion; oral surface of labium not spinulose ..... MELLININAE (Part V)

CC. Body without pleural lobes and dorso-lateral prominences which are dark-tipped and armed with stout spinules; mandibles with one (rarely two) seta near the base laterally, and otherwise not as above; oral surface of prementum of labium spinulose, at least in part.

D. Inner margin of maxilla with a large angular lobe arising from near the base; labrum with the margin not bristly, but with several strong setae set in the margin near the midline; mandibles stout, terminating in four or five teeth which surround a strong ventral concavity ... TRYPOXYLONINAE (Part III)

DD. Inner margin of maxilla without an angular lobe arising from near the base (sometimes with an apical lobe); margin of labrum slightly to strongly bristly.

E. Inner margin of maxilla with a weak to fairly strong apical or subapical prominence which is clothed with spinules or papillae; pleural lobes of thorax often conically protuberant; opening between atria and subatria of spiracles sometimes armed with a circlet of spines ..... LARRINAE (Part IV)

EE. Inner margin of maxilla simple, smoothly rounded, spinulose; pleural lobes of thorax rounded (in diapausing larvae all the pleural lobes may be somewhat conical); opening between atria and subatria always simple.

CRABRONINAE (Part III)

Working Key to Genera of Nearctic Sphecid Larvae[4]

1. Apex of labium very broad, the spinneret a transverse slit with raised lips (V: fig. 33)[5] (Sphecinae) 2
   Apex of labium narrower, the spinnerets paired, each opening at the end of a short or long process (V: fig. 28) 10
2. Labrum without prominent, protruding sensory cones and with the setae minute or absent (V: fig. 31) 3
   Labrum with a series of prominent sensory cones and with rather large setae (I: fig. 65) 8
3. Mandibles stout and heavy, less than twice as long as their maximum width, without spinules on their upper surfaces (I: fig. 22) (Sphecini) 4
   Mandibles slender, more than twice as long as their maximum width, bearing minute spinules on their upper surfaces (V: fig. 32) (Ammophilini) 7
4. Head (excluding labrum) higher than broad (I: fig. 15) ... *Priononyx*
   Head (excluding labrum) broader than high (I: fig. 1) 5
5. Body cylindrical, the thorax with paired subdorsal elevations (I: fig. 25); galeae horn-shaped, considerably exceeding the maxillary palpi (I: fig. 28) ..... *Isodontia*
   Body more fusiform, the thorax without such elevations (I: fig. 3); galeae not or slightly exceeding the maxillary palpi (I: fig. 6) 6
6. Punctures of labrum very numerous and spread over much of the surface (I: fig. 12) ..... *Palmodes*
   Punctures of labrum largely confined to the apical half (I: fig. 9). *Sphex*
7. Basal tooth of mandibles represented by a row of about 7 minute denticles (I: fig. 34) ..... *Podalonia*
   Basal tooth of mandibles simple or subdivided, but always protruding as a distinct tooth (I: figs. 44–46) ..... *Ammophila*

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[4] This key is based on fully grown, non-diapausing larvae. It may, in some cases, work for larvae which are not fully grown, and it should work for most diapausing larvae if allowances are made for changes in body shape and for wear of the mandibles and spinnerets. The key includes approximately two-thirds of the genera occurring north of Mexico, but it does include most of the genera which occur commonly in the northeastern quarter of the United States. For the most part, the key is based upon the generic tables presented under the various subfamilies but I have made numerous changes based on further experience. I cannot emphasize too strongly the tentative nature of this key. Generalizations on generic characters drawn from a few specimens are always dangerous, and such generalizations drawn from published descriptions of one or two species (as some of these are) are even more apt to require modification. If this key serves only to challenge workers to improve it, it will have served a useful purpose.

[5] To illustrate each character I have selected a single figure of a fairly typical species. All specimens should not be expected to be identical to the figures selected. The roman numeral indicates the part of this series of papers in which the figure is found.

8. Setae on head capsule sparse and minute (I: fig. 69); thoracic callosities weakly pigmented (I: fig. 71) (Podiini) ..... *Podium*
   Setae on head capsule fairly strong, moderately abundant (I: fig. 68); thoracic callosities unpigmented (I: fig. 52) (Sceliphronini) 9
9. Top and sides of head capsule very strongly roughened by small convexities (I: fig. 68) ..... *Chalybion*
   Top and sides of head capsule only weakly roughened (I: fig. 50). *Sceliphron*
10. Antennal papillae absent, the sensory cones arising directly from the membrane of the orbit (III: fig. 37) 11
    Antennal papillae present, long or short, bearing the sensory cones at their tip (III: fig. 6) 37
11. Anus terminal, directed caudad (IV: fig. 49); antennal orbits large (IV: fig. 50) (Pemphredonini, in part) 12
    Anus ventral and preapical, directed ventrad, the anal segment forming a rounded or conical lobe beyond the anus (IV: fig. 29) 15
12. Integument spinulose at least anteroventrally (IV: fig. 51); apical margin of labrum usually with a pigmented band (IV: fig. 53) 13
    Integument entirely without spinules; apical margin of labrum usually not pigmented (IV: fig. 66) 14
13. Integument rather evenly spinulose anteriorly, including the thoracic dorsum ..... *Passaloecus*
    Integument spinulose only on parts of the sides and venter. *Pemphredon*
14. Body somewhat fusiform; maxillae slightly roughened by small papillae or spinules (IV: fig. 67) ..... *Xylocelia*
    Body more cylindrical; maxillae smooth (IV: fig. 69) ..... *Stigmus*
15. Body with pleural lobes and a series of dorso-lateral prominences conically produced, dark-tipped, and armed with a series of stout spines (V: figs. 23, 27) (Mellininae) ..... *Mellinus*
    Body without pleural lobes and dorso-lateral prominences which are dark-tipped and armed with stout spines 16
16. Inner margin of maxilla with a large angular lobe arising from the base (III: fig. 42); apical margin of labrum not bristly, but with several setae near the midline (III: fig. 41) (Trypoxyloninae) 17
    Inner margin of maxilla without a basal angular lobe, either evenly rounded (III: fig. 73) or with a rounded subapical prominence (IV: fig. 38); apical margin of labrum almost always bristly (IV: fig. 37) 20
17. Lacinial lobe with very strong spines (V: fig. 68); head and body with remarkably long setae (V: figs. 64, 70) ..... *Pisonopsis*
    Lacinial lobe with weak spines (III: fig. 42); head setae of moderate length, body setae inconspicuous (III: fig. 36) 18

18. Posterior end of body somewhat conically produced beyond the anus (III: fig. 58); spinnerets much exceeding the labial palpi (III: fig. 60) ..... *Trypoxylon*, subgenus *Trypoxylon*
Posterior end of body rather blunt (III: fig. 39); spinnerets exceeding the labial palpi slightly if at all (III: fig. 43) 19
19. Labrum without sensory cones (III: fig. 41), or some may be present near the midline (III: fig. 33); head somwehat more weakly setose than below (III: fig. 36) ..... *Trypoxylon*, subgenus *Trypargilum*
Labrum with several sensory cones antero-laterally (III: fig. 68); head strongly setose (III: fig. 65) ..... *Pison*
20. Mandibles slender, with three or four teeth in about the same plane, or the apical two one above the other, never with a distinct ventral, apical concavity (rarely edentate) (III: figs. 97, 100, 101) (Crabroninae, in part) 21
Mandibles stouter, with four or, more commonly, five teeth and with a distinct ventral, apical excavation (III: figs. 87–89) 25
21. Mandibles simple, with only the apical tooth ..... *Tracheliodes*
Mandibles with three or four teeth 22
22. Galeae very short, not more than one third the length of the maxillary palpi (V: fig. 52) ..... *Lindenius*
Galeae at least nearly half as long as the maxillary palpi (III: fig. 73) 23
23. Oral surface of prementum of labium with a very dense covering of very short spinules ..... *Entomognathus*
Oral surface of prementum of labium with fewer and longer spinules (III: figs. 70, 103) 24
24. Teeth of mandibles in nearly the same plane, in lateral view the penultimate tooth only slightly evident (III: fig. 101) ..... *Euplilis*
Apical two teeth of mandibles juxtaposed in such a way that the mandibles are strongly bifid apically in lateral view (III: fig. 97). *Crossocerus*
25. Apical portion of maxilla a rounded lobe, spinulose but not notably produced on the inner margin (III: fig. 92); pleural lobes of anterior part of body not conically produced (III: fig. 71) (Crabroninae, in part) 26
Apical portion of maxilla somewhat produced on the inner margin (IV: fig. 38); pleural lobes of anterior part of body often conically produced (IV: figs. 29, 30) (Larrinae) 29
26. Base of mandibles with two lateral setae (III: fig. 82); labium with two patches of very long spinules (III: fig. 84) ..... *Anacrabro*
Base of mandibles with one lateral seta (III: fig. 87) 27
27. Epipharynx with a large area medio-apically which is devoid of spinules, either bare or papillose (III: fig. 111) ..... *Oxybelus*
Epipharynx spinulose medio-apically (III: fig. 90) 28

28. Mandibular teeth strong, the ventral excavation also strong (III: figs. 87–89); galeae about two-thirds the length of the maxillary palpi (III: fig. 92) ..... *Ectemnius*

    Mandibular teeth slightly less prominent, the fifth (ventral, basal) tooth especially weak, the ventral excavation somewhat weaker than above (V: fig. 47); galeae not much over half the length of the maxillary palpi (V: fig. 48) ..... *Crabro*

29. Inner margin of maxillae with, at most, some elongate papillae (IV: fig. 45); body setae rather strong 30

    Inner margin of maxillae densely spinulose (V: fig. 57) 32

30. Anterior lateral angles of epipharynx with a group of large, blunt spinules quite different from those on the remainder of the epipharynx (IV: fig. 44) ..... *Solierella*

    Anterior lateral angles of epipharynx without such spinules 31

31. Inner margin of maxilla prolonged into a sharp point ..... *Miscophus*

    Inner margin of maxilla not prolonged as above ..... *Nitela*

32. Epipharynx with a dense covering of unusually strong spinules which converge upon a bare area in the center (IV: fig. 41) ..... *Motes*

    Epipharynx without unusually strong spinules which converge upon a bare area in the center (IV: fig. 37) 33

33. Prothoracic dorsum with a transverse series of conspicuous setae (IV: fig. 22); head setae long, the longest ones considerably longer than the diameter of the antennal orbit (IV: fig. 33) 34

    Prothoracic dorsum with only minute setae (IV: fig. 10); head setae shorter, not usually longer than the diameter of the antennal orbit (IV: fig. 13) 35

34. Central part of epipharynx bare or with a few papillae or blunt spinules (IV: fig. 23); prothoracic lobes conical (IV: fig. 22). *Tachysphex*

    Central part of epipharynx densely clothed with long spinules (IV: fig. 37); upper pair of prothoracic lobes very slender, digitiform (IV: fig. 30) ..... *Larropsis*

35. Opening between atrium and subatrium of spiracles simple, unarmed (V: fig. 55); small larvae, the head capsule well under 1 mm. wide. *Plenoculus*

    Opening between atrium and subatrium armed with a circlet of spines (IV: fig. 17); larger larvae 36

36. Pleural lobes of thorax very prominent, conical, the prothorax with three pairs of such lobes (IV: fig. 10); mandibles with five teeth. *Tachytes*

    Pleural lobes of thorax not unusually prominent; mandibles with four teeth, one of the basal teeth cuspate (IV: figs. 58, 59) ..... *Larra*

37. Mandibles less than twice as long as their maximum breadth (V: fig. 16); maxillae directed strongly mesad, their inner margin short (IV: fig. 8) 38

Mandibles about or more than twice as long as broad (V: figs. 20, 63; III: figs. 5, 12) 41

38. Mandibles with several setae near the base laterally (IV: fig. 46); fourth abdominal segment with a dorsal hump (IV: fig. 1) (Astatinae) ..... *Astata*

Mandibles with one seta near the base laterally, or none at all; fourth abdominal segment no more humped than any other (V: fig. 15) (Pemphredoninae, in part) 39

39. Head with a few rather large setae (V: fig. 13); galeae small but well-defined (V: fig. 19) ..... *Diodontus*

Head with small setae or none at all; galeae very minute (in two instances figured as being absent) 40

40. Integument of body covered with small setae; head, including clypeus and labrum, with many small setae ..... *Ammoplanus*

Integument of body smooth; head, including clypeus and labrum, without setae ..... *Spilomena*

41. Integument smooth or very inconspicuously spinulose; body setae, when present, relatively sparse (Nyssoninae) 42

Integument almost wholly clothed with close-set spinules (best seen under high magnification) (III: fig. 7) 54

42. Front with from one to six dark-tipped, nipple-like processes (II: figs. 1, 8); labrum with only minute setae if any (II: fig. 4) 43

Front without dark-tipped, nipple-like processes (II: fig. 13); labrum with strong setae (II: fig. 16) 44

43. Front with six nipple-like processes (II: fig. 1); antennal papillae unusually long (II: fig. 6) (Alyssonini) ..... *Alysson*

Front with one or three nipple-like processes (II: fig. 8); antennal papilla short (II: fig. 9) (Nyssonini) ..... *Nysson*

44. Mandibles tridentate, the two basal teeth close together, each in a slightly different plane (II: fig. 37) (Stizini) ..... *Bembecinus*

Mandibles with from two to four teeth distributed along the inner margin, all in the same plane (V: figs. 62, 63) 45

45. Tooth on inner margin of mandibles broad, truncate, molar-like (II: fig. 58) 46

Mandibular teeth all simple (V: figs. 62, 63) 48

46. Antennal papillae barely longer than thick (II: fig. 24); labrum very weakly bristly apically (II: fig. 26) (Gorytini, in part) .. *Ochleroptera*

Antennal papillae much longer than thick (II: fig. 46); labrum strongly bristly apically (II: fig. 48) (Bembicini, in part) 47

47. Inner margin of maxillae with flat papillae (II: fig. 81); epipharyngeal sensory areas not connected by a pigmented band (II: fig. 82). *Microbembex*

Inner margin of maxillae strongly spinulose (II: fig. 52); epipharyngeal sensory areas connected by a pigmented band (II: fig. 48) .. *Bicyrtes*

48. Epipharynx spinulose between the two epipharyngeal sensory areas (V: figs. 39, 40) 49
Epipharynx bare between the two epipharyngeal sensory areas (V: figs. 41, 42) (Bembicini, in part) 52
49. Apical margin of labrum strongly bristly, the disc with a large number of strong setae (II: fig. 61) (Bembicini, in part) ..... *Stictiella*
Apical margin of labrum weakly to moderately bristly, the disc with a smaller number of weaker setae (V: figs. 39, 40) (Gorytini, in part) 50
50. Parietal bands present, although rather weak (II: fig. 30); width of head capsule well over 1 mm. ..... *Sphecius*
Parietal bands absent (II: fig. 13); width of head capsule well under 1 mm. 51
51. Apical margin of labrum with not more than about 20 well-separated sensory cones (II: fig. 16) ..... *Gorytes*
Apical margin of labrum with from 22 to 36 sensory cones which form a very crowded series (V: figs. 39, 40) ..... *Psammaecius*
52. Large larvae, the head capsule about or more than 2 mm. in width; integument minutely spinulose (II: fig. 74) ..... *Stictia*
Smaller larvae, the head capsule well under 2 mm. in width; integument not spinulose 53
53. Lateral portions of epipharynx spinulose, with a narrow pigmented band (II: fig. 67); body setae virtually absent ..... *Steniolia*
Lateral portions of epipharynx variable, but generally more papillose than spinulose (V: figs. 41, 42); body setae variable, but in most species fairly abundant, although inconspicuous ..... *Bembix*
54. Oral surface of prementum strongly papillose (III: fig. 8); body slender, elongate-fusiform, the tenth abdominal segment modified to function as a proleg (III: figs. 3, 13) (Philanthinae) 55
Oral surface of prementum bare (V: fig. 10); body stouter and more grub-like (V: fig. 3) (Psenini, in part) 58
55. Mandibles tridentate or weakly quadridentate (III: figs. 5, 12); epipharynx with spinules over most of its surface (III: fig. 4) (Philanthini) 56
Mandibles bidentate (III: fig. 29); epipharynx with a considerable area medio-basally which is devoid of spinules or papillae (III: figs. 30, 34) (Cercerini) 57
56. Mandibles weakly quadridentate (III, fig. 5); lacinial area with a small finger-like process (III: fig. 9) ..... *Aphilanthops*
Mandibles tridentate (III: fig. 12); lacinial area simple (III: fig. 18). *Philanthus*
57. Head slightly higher than wide, somewhat elliptical in anterior view (III: fig. 22); supra-anal lobe surpassing the subanal (III: fig. 23) *Cerceris*

Head much higher than wide, nearly parallel-sided (III: fig. 32); anal segment tubular, the supra-anal and subanal lobes equally prominent (III: fig. 33) ..... *Eucerceris*

58. Apical abdominal segment with a conical protuberance above the anus (V: fig. 3) ..... *Pluto*
Apical abdominal segment rounded (V: fig. 12) ..... 59[6]

59. Labrum not or weakly emarginate (V: fig. 21) ..... *Mimesa*
Labrum strongly emarginate (V: fig. 7) ..... *Psen*

The Evolution and Classification of the Sphecidae as Suggested by Larval Characters

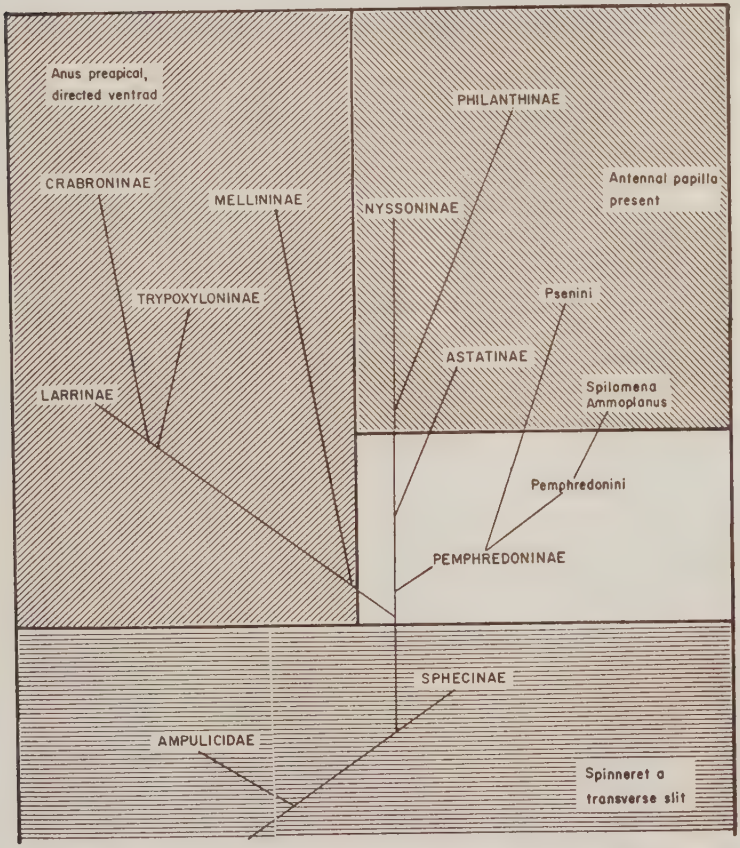
Since all of the subfamilies and most of the tribes and genera of Sphecidae can be characterized on the basis of larval structure, it is only natural to ask what suggestions can be found in these characterizations with respect to the evolution and classification of the Sphecidae. Before attempting to answer this question it is necessary to list some of the major characters which differ and to decide which alternative is primitive and which is specialized. We would expect the more primitive sphecid larvae (1) to be most similar to the larvae of other wasps, particularly groups generally considered primitive (e.g., Scolioidea), and (2) to occur in groups of Sphecidae generally considered primitive on the basis of adult structure and of ethology. Using these criteria, we can list the following alternatives as being primitive or specialized:

[6] If the mandibles are stout and with the teeth apical rather than distributed along the inner margin as in V: figs. 20, 22, cf. couplet 39.

Primitive	*Specialized*
1. Integument smooth or with sparse, small setae or spinules.	Integument with abundant setae or dense spinules.
2. Body with more or less even contours.	Body with conspicuous projections, either laterally, dorsally, or caudally.
3. Anus more or less terminal, directed caudad.	Anus ventral, preapical, directed ventrad.
4. Opening between atrium and subatrium of spiracles armed with a circlet of spines.	This opening simple, unarmed.
5. Parietal bands present.	Parietal bands absent.
6. Antennal papillae absent.	Antennal papillae present.
7. Mandibles simple, with four or five apical teeth.	Mandibles either with fewer teeth or with an apical concavity.
8. Maxillae directed mesad apically, closely associated with the labium and hypopharynx.	Maxillae projecting apically as large, free lobes.
9. Galeae large.	Galeae small.
10. Spinneret a transverse slit.	Spinneret with paired openings, each at the end of a projection.

Further comment on some of these characters is perhaps in order. I do not deny that in the Hymenoptera as a whole the presence of antennae and the presence of abundant body setae are primitive (characters 1 and 6 above). Yet I find it necessary to conclude that the most primitive Sphecidae lacked antennae and abundant body setae. The larvae of Scoliidae which have been described lack an antennal papilla and the integument is smooth; this is also true of the Ampulicidae (often regarded as a primitive stock of Sphecoidea) and several groups of Sphecidae regarded as primitive on adult characters. It should be remembered that the aculeates as a whole probably evolved from a now-extinct parasitoid stock. The larvae of these ancestral aculeates must have undergone a great many structural reductions because of their intimate association with their hosts. With the evolution of nesting behavior, the larvae were often confronted with greater problems: for example, the necessity of moving about in a cell and consuming several host specimens. Such structures as antennae, tactile setae, and various types of pseudopods, present in their remote ancestors, the sawflies, may once again have been useful. At one time selected against, these

structures were selected for, and were gradually reacquired independently by various stocks of aculeates, not always in exactly the same form. Antennal papillae have been acquired by the Chrysididae, Pompilidae, and by at least two and perhaps as many as four stocks of Sphecidae (see text-figure 1). In each



Text-figure 1.—A phylogenetic tree of the major groups of Sphecidae, with primary emphasis on the three characters indicated. For further explanation see text.

instance the small sensory cones which are located in the membrane of the orbit in the Scoliidae, Vespidae, Ampulicidae, etc., are raised well above the surface of the orbit, the sides of the elevation becoming constricted and sclerotized. I gather from the various papers of G. C. and J. Wheeler that most ant larvae lack antennal papillae, but several groups of ants have independently acquired some device for elevating the antennal sensory cones.

Michener (1953, Kansas Univ. Sci. Bull., 35: 997–1000) encountered this same problem in his studies of bee larvae. He lists as specialized the loss of body setae and the loss of antennal papillae, yet he finds these supposed specializations chiefly in groups of bees regarded as primitive on most other characters. He discusses the probability that certain structures of bee larvae were lost early in bee evolution and later regained, and presents reasons why the so-called " law of irreversibility " should be expected to have many exceptions. He concludes that while mandibular structures offer characters of phylogenetic value, " the other structures considered, probably because of reversions, show a reversal of expected phylogenetic significance. If the hypotheses presented are correct, the primitive and specialized alternatives for these characters . . . should be reversed for the bees."

Certain other characters considered in my list are of perhaps minor phylogenetic significance. For example, the loss of spines guarding the spiracular openings seems to go along with a decrease in body size, presumably because the opening itself becomes so small that most foreign particles cannot gain entry. Even so, characters such as these are probably as significant as reductions in wing venation and in the number of tibial spurs, characters which are weighed heavily in classifications based on adult characters, yet which are correlated (at least roughly) with reduction in body size.

The most primitive sphecids: the Sphecinae.—If one reads down the " primitive " column for the ten characters listed above, he obtains an accurate summary of the larval characters of the Sphecinae, for these wasps are primitive in all ten characters. There can be no doubt that the larvae of Sphecinae are most like

those of other wasps, including the Ampulicidae, often regarded as primitive sphecoids. The most striking feature of the Sphecinae is the transverse spinneret which is very different from that of other Sphecidae. It is difficult to decide which of the major tribes of Sphecinae is most primitive. The labrum of the Sphecini is strikingly like that of both the Ampulicidae and the Pemphredonini. The mandibles of the Ammophilini are slender and possess spinules on their upper surface, although the labrum is of the same form as in the Sphecini. The tribes Podiini and Sceliphronini have very similar larvae; in these groups the mandibles are unspecialized but the labrum has a series of large sensory cones as in many higher Sphecidae. Thus it would seem that the Sphecini have the fewest specializations.

The gap between the Sphecinae and other Sphecidae is a considerable one (considering the small differences which usually occur between larvae of different groups of aculeates), but there can be no doubt that some groups have more primitive characteristics—and therefore more characters in common with the Sphecinae—than others. An actual tabulation reveals that the Pemphredonini have the fewest specialized characters (three) of any group besides the Sphecinae, and two of these specializations (characters 4 and 5) may merely be tied up with the small size of these wasps.

The Pemphredoninae.—I have already noted the strong resemblance of the labrum of the Pemphredonini to that of the Sphecini. Resemblance of these larvae also extends to general body form and to many features of the mandibles and maxillae. In the Pemphredonini the spinnerets, although paired, are generally broad and blunt and have a membranous connection between them, suggesting an evolution from the type characteristic of the Sphecinae. It seems not improbable that the Pemphredonini evolved from an ancestor which, if we had in hand, we might place in the tribe Sphecini.

The genera *Ammoplanus* and *Spilomena,* however, depart considerably from *Pemphredon* and its allies. These genera have the labrum simple, non-emarginate apically, antennal papillae are present, and the galeae are greatly reduced and may even be absent. These differences are greater than one would expect

within a single tribe of wasps, and *Ammoplanus* and certain other genera have, in fact, sometimes been placed in a separate tribe, the Ammoplanini. The Psenini also possess antennal papillae, and most genera have elongate mandibles and the body clothed densely with spinules. These three characters also occur in the Philanthinae and I had at first believed that the Psenini might be unrelated to the Pemphredonini and tied in with the philanthine-nyssonine complex. However, the larva of *Diodontus* is an almost perfect mixture of the characters of the Pemphredonini and the more specialized Psenini. Thus it seems probable that the Psenini have evolved from the Pemphredonini and any resemblance between the larvae of such genera as *Psen* and *Philanthus* must be interpreted as due to convergence. This is supported by adult characters as the Psenini are commonly considered but a tribe of Pemphredoninae.

In general, then, one can say that the subfamily Pemphredoninae exhibits an unusual amount of variation in larval form, some elements being rather primitive and close to the Sphecinae, other elements highly evolved. The subfamily is held together, however, by certain subtle features: the supra-anal lobe always exceeds the subanal, the antennal orbits are relatively large and widely separated, the epipharyngeal sensilla are peg-shaped, the maxillae are strongly directed mesad, and the spinnerets are more or less connected basally.

The Astatinae.—The larvae of the Astatinae are specialized in only four of the ten characters listed above. Other than in their generally unspecialized body form, they bear no striking resemblance to the Pemphredoninae, although the head is very broad and the mandibles not greatly dissimilar to those of the Pemphredonini. The prominence on the fourth abdominal segment and the numerous setae on the mandibles are unique features. The characters of the labrum and epipharynx are not at all unlike those of the Nyssoninae and Philanthinae; this includes particularly a prominent series of barrel-shaped sensilla along the margin of the labrum. It is perhaps significant that the Nyssoninae and Philanthinae also generally have more than one seta on the base of the mandibles. In my phylogenetic tree (text-fig. 1), I have associated the Astatinae with the stem leading

to the Nyssoninae and Philanthinae, and I feel that this is supported by ethological characters (Evans, 1958, Jour. N. Y. Ent. Soc., 65: 159–185). One could possibly justify almost as well associating them with the stem leading to the Pemphredoninae or putting them on an independent stem arising from the Sphecinae. But it would be impossible to place them close to the Larrinae as is often done on the basis of adult structure.

The nyssonine-philanthine complex.—In this complex the Gorytini occupy a central position and are specialized in only four or five of the ten characters considered above. Unlike the three subfamilies considered up to this point, the maxillae project as large lobes free of any close association with the labium or hypopharynx. I have already pointed out that the Alyssonini and Nyssonini appear to represent sidewise specializations from the Gorytini, and that the Stizini and Bembicini appear to be derived directly from the Gorytini (Part II, pp. 37–38). Trends in specialization include an increase in the number of body setae and in the number and length of bristles on the margin of the labrum and, in certain genera, specializations in the mandibles.

The larvae of the Philanthinae are among the most specialized of all digger wasps; they depart from the primitive in all but one of the ten characters considered earlier. They agree with the Nyssoninae in having slender mandibles usually bearing several setae, in having barrel-shaped sensilla and numerous bristles on the margin of the labrum, in having dense spinules and well-defined sensory areas containing pore-like sensilla on the epipharynx, and in having papillae on the oral surface of the labium. I do not feel that the relationship of these two subfamilies is especially close, yet it is impossible to place them other than on the same stem of the phylogenetic tree.

Within the Philanthinae, the mandibles are most primitive in *Aphilanthops* (Philanthini), most specialized in the Cercerini. On the other hand, the maxilla of *Aphilanthops* is specialized and the least reduction of the galeae occurs in *Cerceris*. Doubtless the two tribes evolved from a common ancestor possessing the primitive characters of each.

The larrine-trypoxylonine-crabronine complex.—On the basis of larval characters this is a closely-knit complex of subfamily status. The anus is preapical and directed ventrad; antennal papillae are absent; the labrum lacks the large sensory cones found in the preceding complex; the mandibles have a single seta (except two in *Anacrabro*) and are generally stout and with an apical concavity (some exceptions in the Crabroninae); the oral surface of the labium is spinulose. *Trypoxylon, Pison,* and *Pisonopsis* differ from other members of the complex in possessing an angular, basal lobe on the inner margin of the maxilla and in having the margin of the labrum non-bristly but supplied with several median setae. *Pisonopsis,* however, has long head and body setae and accessory prothoracic lobes much like certain larrines, and even the lacinial lobe is somewhat intermediate between that of *Trypoxylon* and that of most Larrinae. (On the basis of adult structure, *Pisonopsis* is also somewhat intermediate between these two groups.) The larrine tribes Larrini and Miscophini cannot be separated on larval characters, the crabronine tribes Crabronini and Oxybelini can be separated only doubtfully on weak characters, and in fact the subfamilies Larrinae and Crabroninae can scarcely be separated except by a compilation of the characters of the known genera. There can be no question that, on the basis of larval characters alone, this complex should be given the status of a single subfamily.

The complex does not seem to be related closely to any other group of Sphecidae. In the Larrinae, some genera possess a circlet of spines in the opening between the spiracular atrium and subatrium, and in general the Larrinae seem to have few specializations. In the Crabroninae some genera (such as *Ectemnius*) agree closely with the Larrinae in most characters, including the mandibles (compare, for example, III: figs. 63 and 88, IV: fig. 32, all basically similar mandibles). In other Crabroninae the mandibles tend to become more slender and to loose the ventral concavity (*Euplilis, Lindenius*), while in *Trachelioides,* according to Grandi, the mandibles are simple and edentate. I would judge genera such as these to be among the most specialized members of this complex. It is interesting to note the resemblance of the mandibles of (for example) *Lindenius* (V:

fig. 51) to those of *Bembix* (V: fig. 63) and *Pluto* (V: fig. 1). These genera are quite unrelated, and each represents one of the more highly evolved members of its particular complex. Apparently slender mandibles with four teeth more or less evenly spaced along the inner margin have evolved several times independently in the Sphecidae.

The Mellininae.—The larvae of Mellininae agree with members of the preceding complex in having the anus ventral and preapical and in lacking antennal papillae. Otherwise they do not have a great deal in common with the Larrinae and their relatives. The fact that the maxillae are produced mesad and closely associated with the labium suggests that the group is primitive, but the unusual mandibles and the peculiar spines on parts of the body are specialized. The group does not appear to be closely related to any other. It may have arisen from a stock which later gave rise to the Larrinae and their relatives, as suggested in text-fig. 1. On the other hand there is no reason why it might not have had a different origin and have acquired the ventral, preapical anus independently. However, the group is apparently not closely related to the Nyssoninae, in which subfamily it has sometimes been placed as a tribe.

Relationships as suggested by adult characters.—A detailed study of the comparative morphology of adult Sphecidae has yet to be made. Certain structures, in particular the male terminalia, remain almost wholly unstudied. Nor is there any general agreement on how many subfamilies (or families) make up this complex or how the groups are inter-related. However, Leclercq (1954, Monographie systématique . . . des Hyménoptères Crabroniens, Liege, 371 pp.) has recently reviewed these matters briefly and presented a phylogenetic tree of the Sphecidae based on adult structure and supported by ethological data. For present purposes it seems to me sufficient to comment on some of the differences between Leclercq's tree (his fig. 1, p. 21) and mine (text-fig. 1).

In the first place, Leclercq accepts fifteen subfamilies in contrast to the nine recognized in the present studies. He considers the ampulicids a subfamily closely related to the Sphecinae.

(This is fully supported by larval characters, although I have excluded the group from these studies and hope to treat it separately.) He ranks the Crabroninae, Oxybelinae, and Karossiinae as separate subfamilies, although these groups are very closely related on the basis of adult characters and the first two not clearly separable on larval characters (the larvae of Karossiinae are unknown). He considers the Philanthinae and Cercerinae separate subfamilies, although he does place them close together on the same branch of the phylogenetic tree. The Bembecinae, Stizinae, Alyssoninae, and Nyssoninae are all given subfamily status, with *Mellinus* included in the Nyssoninae. Larval characters suggest that all of these (except *Mellinus*) form a single complex and I believe that this can be supported on the basis of adult characters. Leclercq does, in fact, put them close together in his phylogenetic tree.

When it comes to a consideration of the actual relationships of the major groups of Sphecidae, one notes two major similarities between Leclercq's tree and mine. We both consider the ampulicids and the Sphecinae the most primitive of the complex, in that order. We both consider the Philanthinae among the most highly evolved and derived from the same stock as the Nyssoninae. Thereafter one is more impressed by the differences, which are summarized and to some extent rationalized in the paragraphs which follow.

(1) Leclercq associates the Trypoxyloninae (doubtfully) with the Sphecinae and remarks that they form an isolated group. He does, however, note that F. F. Kohl and O. W. Richards considered them close to the Larrinae. On the basis of larval characters they are not strongly isolated but very close to the Larrinae and Crabroninae. I feel that this association can be justified on adult characters. Adult Trypoxyloninae share many features in common with both the Larrinae and the Crabroninae. This is well illustrated by the genus *Pisonopsis,* which is commonly placed in the Larrinae although it has eyes which are nearly as deeply emarginate as in *Trypoxylon* and *Pison;* the larvae of this genus suggest that it is more properly placed in the

Trypoxyloninae, although there are some larrine characters. Although the male genitalia of the Trypoxyloninae are rather unusual, the volsellae are simple and not divided into the usual digitus and cuspis (see Snodgrass, 1941, Smithson. Misc. Coll., v. 99, pl. 21, O, Q). This is also the condition in the Larrinae (Snodgrass's pl. 20, Q) and the Crabroninae (his pl. 20, R).[7]

(2) Leclercq regards the Crabroninae as related to the Pemphredoninae and both these groups derived from nyssonine stock. He does, however, present reasons (to me more convincing) for deriving the Crabroninae from the Larrinae. Personally, I am inclined to wonder if the two groups are any more sharply separated on adult characters than on larval characters. Some genera of Larrinae (e.g. *Bothynostethus*) are remarkably *Crabro*-like. I know of no Larrinae which approximate the *Crabro*-type wing venation (although *Trypoxylon* does); however, the venation of the Crabroninae can easily be derived from that of the Larrinae.

(3) Leclercq states that the Pemphredoninae may be related to the Nyssoninae but that the separation must have been very early since the Pemphredoninae retain many primitive characters. However, his phylogenetic tree shows them arising from high in the Nyssoninae, after the separation of the Stizinae, Bembicinae, etc. This position seems to me difficult to defend on any grounds. But if one moves them well down on the nyssonine stem, in accord with Leclercq's text, he approximates the condition shown in my phylogenetic tree. I do not feel that the Nyssoninae and Pemphredoninae have a close relationship, but they may well have a common ancestry as distinct from that of the Larrinae and their relatives.

(4) Leclercq places the Astatinae close to the Larrinae. This is the conventional point of view and can be defended well on the basis of adult structure. I can only say that larval structure does not support this view. It is perhaps worth noting that the volsellae of *Astata* have the usual division into digitus and cuspis (Snodgrass, ibid., pl. 20, L) and the pygostyles are preserved (in

[7] I have examined the genitalia of several genera not covered by Snodgrass. However, it is possible that exceptions to these statements will be found when the genitalia of all genera have been studied in a critical manner.

common with the Sphecinae). Perhaps what passes for similarity between the Astatinae and Larrinae is no more than the preservation of a rather primitive adult body form.

(5) The Mellininae are not considered by Leclercq, who presumably includes *Mellinus* in the Nyssoninae. Again, this is a view held by many hymenopterists and defensible on the basis of adult structure. However, in their nesting behavior the Mellininae differ greatly from the Gorytini (which they most closely resemble in adult structure). The male genitalia (not described by Snodgrass) differ markedly from all other Sphecidae in possessing very complex parameres and aedeagus. To my mind *Mellinus* is different enough from other Sphecidae to justify being placed in its own subfamily. Whether it evolved from a primitive nyssonine stock, as suggested by adult structure, or a primitive larrine stock, as suggested by larval structure, or whether it had some other origin, it is impossible to state with certainty.

Suggested changes in the classification of the Sphecidae.— Nothing I have said in these pages indicates that any radical changes are needed in the existing classification of the Sphecidae. Larva-wise there are seven major groups: Sphecinae, Pemphredoninae, Astatinae, Nyssoninae, Philanthinae, Mellininae, and the Larrinae-Trypoxyloninae-Crabroninae complex. For the present it seems to me wise to retain the last three groups as subfamilies even though the larvae suggest only one, although further consideration of this point is certainly in order. *Pisonopsis* should, however, be moved from the Larrinae to the Trypoxyloninae. Persons committed to splitting the Sphecidae into several families will find their views amply justified on the basis of larval characters so long as they do not split any of the seven groups listed above. Doubtless these groups are as distinct as some families of Chalcidoidea now commonly recognized. Yet I question whether the elevation of these groups to family status contributes anything to our understanding of them; surely it renders the group more complex and difficult for a non-specialist.

On the tribal level, larval characters suggest that certain tribes are weak and perhaps based on too few adult characters (e.g. Oxybelini), while other tribes not often recognized may perhaps

be worthwhile (e.g. Ammoplanini). In general, study of the larvae has not proceeded far enough to offer many suggestions with respect to the lower categories. Most genera are clearly recognizable on larval characters, and every effort should be made to describe the larvae of genera as yet unknown. Eventually, different groupings of genera and of species within genera may be indicated. It is interesting to note in certain well-known genera (*Bembix,* in particular) a striking concordance of larval structure and certain aspects of the nesting behavior. On the other hand, the diversity of nesting behavior in *Ammophila* does not seem to be reflected in larval structure, and Karl V. Krombein informs me (*in litt.*) that several species of *Trypoxylon,* having virtually indistinguishable larvae, spin characteristic cocoons.

It goes without saying that any classification should be the result of a careful weighing of a mass of evidence pertaining to all aspects of structure, physiology, and behavior. The study of sphecid larvae is still in its infancy, but there is every reason to believe that larval structure may prove of enormous value in helping to classify these and other groups of aculeate Hymenoptera.

Explanation of Figures

In drawings of the head, the anterior aspect is shown on the left side, the posterior aspect on the right side. In drawings of the labrum, the upper or anterior surface is shown on the left side, the under or posterior surface (epipharynx) on the right side.

Plate XVIII

Fig. 1.—*Pluto albifacies* (Malloch), head.
Fig. 2.—Same, portion of integument of dorsum of prothorax under high magnification.
Fig. 3.—Same, body.
Fig. 4.—Same, labrum and epipharynx.
Fig. 5.—Same, anterior thoracic spiracle.
Fig. 6.—Same, maxillae, labium, and hypopharynx, upper (oral) aspect.
Fig. 7.—*Psen* (*Pseneo*) sp., labrum and epipharynx.
Fig. 8.—Same, portion of integument of dorsum of prothorax under high magnification.
Fig. 9.—Same, apex of maxilla.

Fig. 10.—Same, labium, upper (oral) aspect.
Fig. 11.—Same, antenna.
Fig. 12.—Same, apical abdominal segments.

PLATE XIX

Fig. 13.—*Diodontus atratus parenosas* Pate, head.
Fig. 14.—Same, portion of integument of dorsum of prothorax under high magnification.
Fig. 15.—Same, body.
Fig. 16.—Same, mandible, ventral aspect.
Fig. 17.—Same, labrum and epipharynx.
Fig. 18.—Same, anterior thoracic spiracle.
Fig. 19.—Same, apex of maxilla.
Fig. 20.—*Psen* (*Psen*) *barthi* Viereck, mandible, dorsal aspect.
Fig. 21.—*Mimesa nigra* (Packard), labrum and epipharynx.
Fig. 22.—Same, mandible, dorsal aspect.

PLATE XX

Fig. 23.—*Mellinus arvensis* (Linnaeus), body of diapausing larva.
Fig. 24.—Same, head.
Fig. 25.—Same, anterior thoracic spiracle.
Fig. 26.—Same, apex of maxilla.
Fig. 27.—Same, apex of pleural lobe of a middle abdominal segment.
Fig. 28.—Same, apex of labium, dorsal aspect.
Fig. 29.—Same, labrum and epipharynx.
Fig. 30.—Same, mandible, dorsal aspect.
Fig. 31.—*Ammophila aberti* Haldeman, labrum and epipharynx.
Fig. 32.—Same, mandible, dorsal aspect.
Fig. 33.—Same, apex of maxillae and labium, left half, dorsal (oral) aspect.

PLATE XXI

Fig. 34.—*Ammophila placida* Smith, labrum and epipharynx.
Fig. 35.—*Ammophila pruinosa* Cresson, labrum and epipharynx.
Fig. 36.—*Nysson opulentus* Gerstaecker, labrum and epipharynx.
Fig. 37.—Same, anterior thoracic spiracle.
Fig. 38.—Same, head, lateral aspect.
Fig. 39.—*Psammaecius costalis* (Cresson), labrum and epipharynx.
Fig. 40.—*Psammaecius adornatus* (Bradley), labrum and epipharynx.
Fig. 41.—*Bembix u-scripta* Fox, labrum and epipharynx.
Fig. 42.—*Bembix nubilipennis* Cresson, labrum and epipharynx.

PLATE XXII

Fig. 43.—*Crabro monticola* (Packard), head.
Fig. 44.—Same, portion of integument of venter of prothorax under high magnification.
Fig. 45.—Same, labrum and epipharynx.

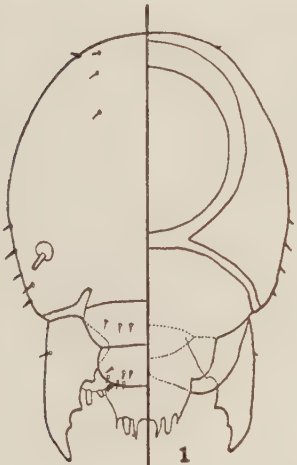
Fig. 46.—Same, body.
Fig. 47.—*Crabro advenus* Smith, mandible, ventral aspect.
Fig. 48.—Same, maxillae, labium, and hypopharynx, dorsal (oral) surface on left, ventral (aboral) surface on right.
Fig. 49.—*Crabro argus* (Packard), anterior thoracic spiracle.
Fig. 50.—Same, labrum and epipharynx.
Fig. 51.—*Lindenius tylotis* Court & Bohart, mandible, dorsal aspect.
Fig. 52.—Same, apex of maxilla.
Fig. 53.—Same, labrum and epipharynx.

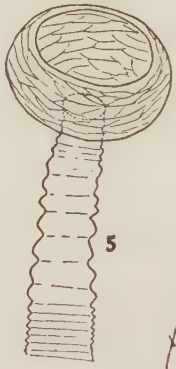
PLATE XXIII

Fig. 54.—*Plenoculus davisi* Fox, head.
Fig. 55.—Same, anterior thoracic spiracle.
Fig. 56.—Same, body.
Fig. 57.—Same, apex of maxilla, labium, and hypopharynx, dorsal (oral) aspect.
Fig. 58.—Same, labrum and epipharynx.
Fig. 59.—Same, mandible, ventral aspect.
Fig. 60.—*Alysson melleus* Say, anterior thoracic spiracle.
Fig. 61.—*Crossocerus fergusoni* Pate, anterior thoracic spiracle.
Fig. 62.—*Psammaecius costalis* (Cresson), mandible, dorsal aspect.
Fig. 63.—*Bembix u-scripta* Fox, mandible, dorsal aspect.

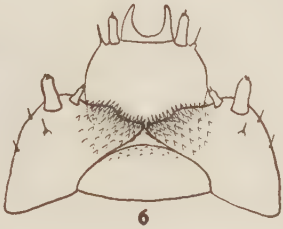
PLATE XXIV

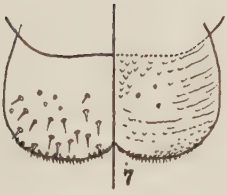
Fig. 64.—*Pisonopsis birkmanni* Rohwer, head.
Fig. 65.—Same, anterior thoracic spiracle.
Fig. 66.—Same, mandible, dorsal aspect.
Fig. 67.—Same, antenna.
Fig. 68.—Same, apex of maxilla.
Fig. 69.—Same, labrum and epipharynx.
Fig. 70.—Same, setal pattern of prothoracic dorsum.
Fig. 71.—*Bembecinus godmani godmani* (Cameron), labrum and epipharynx.
Fig. 72.—Same, apex of maxilla.
Fig. 73.—Same, mandible, dorsal aspect.

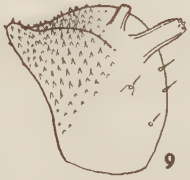


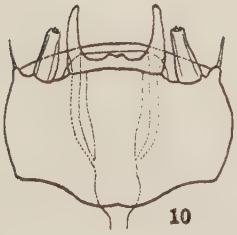


Pluto albifacies (Malloch)









Psen (Pseneo) sp.

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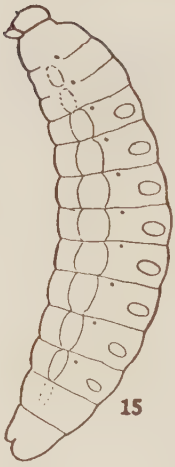
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Diodontus atratus
parenosas Pate

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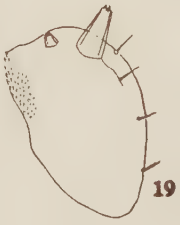
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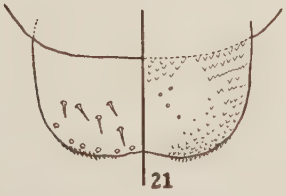
Psen (Psen)
barthi Viereck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Mimesa
nigra (Packard)

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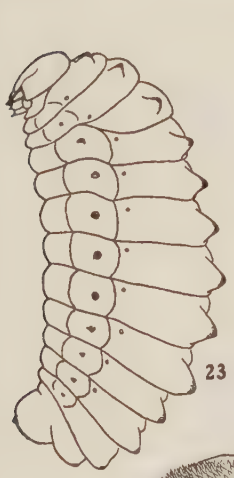
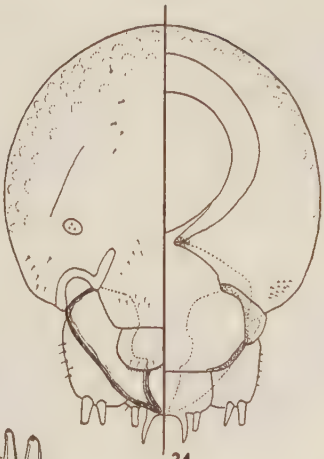
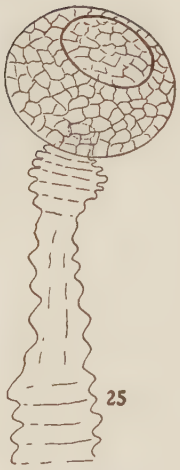
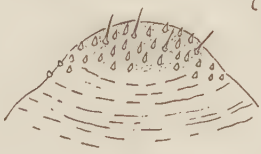
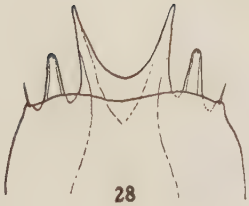
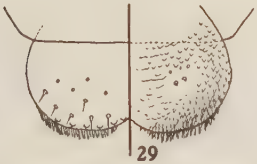




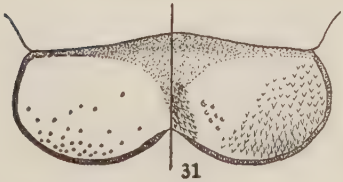




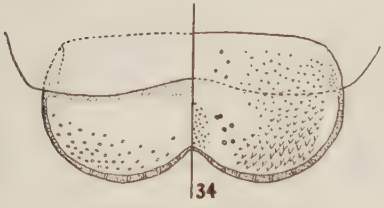




Mellinus arvensis (Linnaeus)



Ammophila aberti Haldeman



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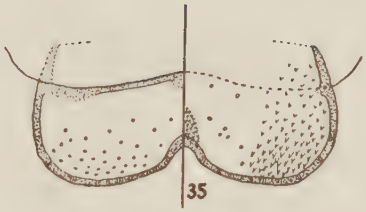
Ammophila placida Smith



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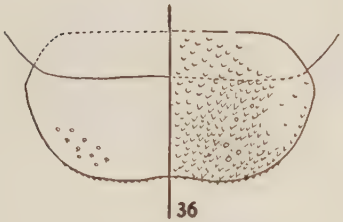
Ammophila pruinosa Cresson



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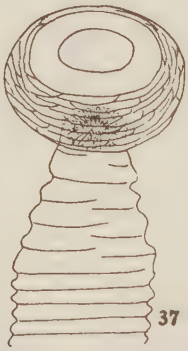
Nysson
opulentus Gerstaecker



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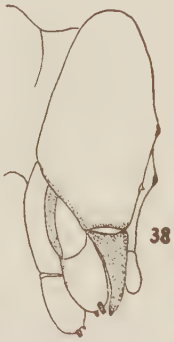

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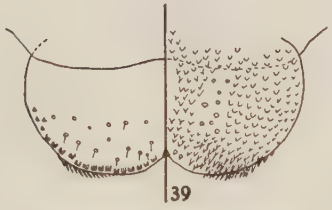

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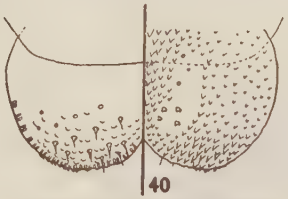
Psammaecius costalis (Cresson)



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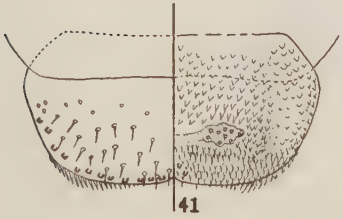
Psammaecius adornatus (Bradley)



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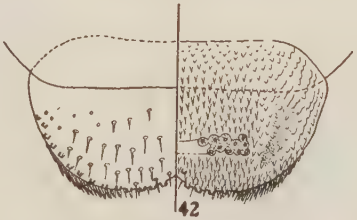
Bembix u-scripta Fox



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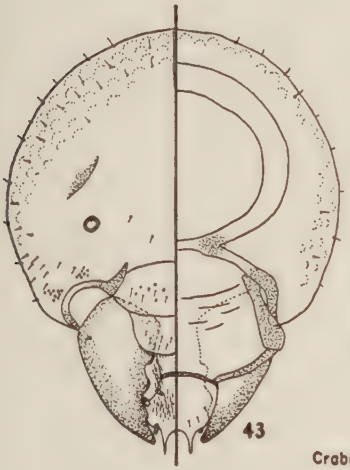
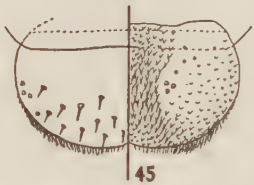
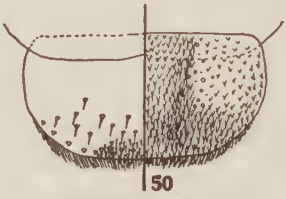
Bembix nubilipennis Cresson



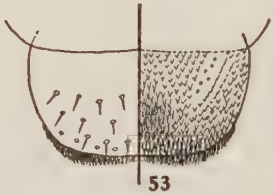


Crabro monticola (Packard)

Crabro advenus Smith

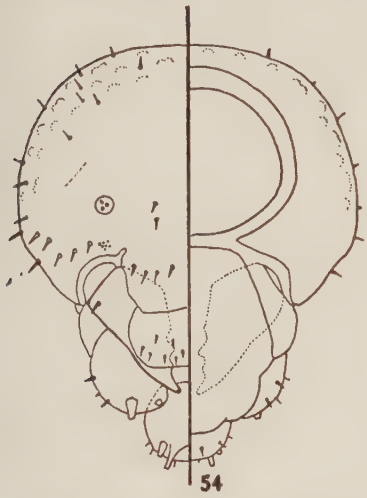


Crabro argus (Packard)



Lindenius tylotis Court & Bohart

EVANS: LARVAE OF DIGGER WASPS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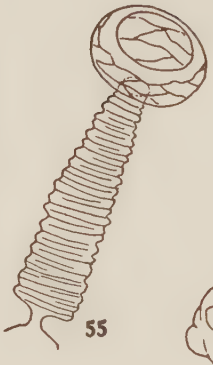
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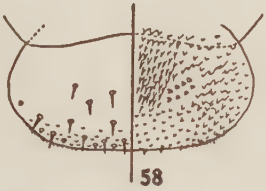
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Plenoculus davisi Fox

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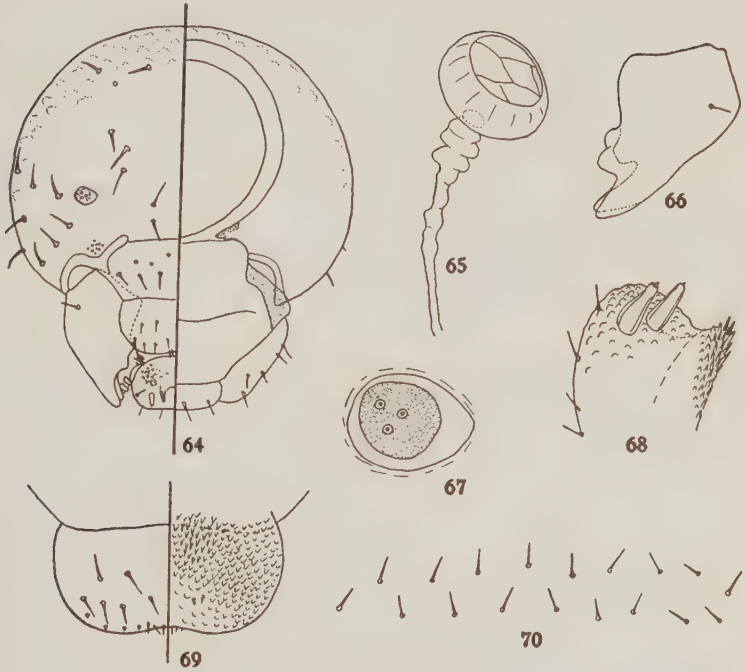
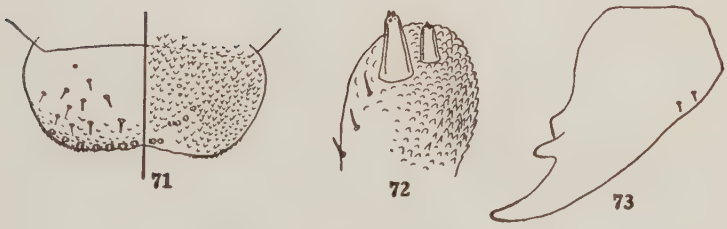


Pisonopsis birkmanni Rohwer



Bembecinus godmani (Cameron)

NEW NORTH AMERICAN TABANIDAE. X. NOTES ON SYNONYMY, AND DESCRIPTION OF A NEW SPECIES OF CHRYSOPS

BY

CORNELIUS B. PHILIP

U. S. Department of Health, Education, and Welfare, Public Health Service, National Institutes of Health, National Institute of Allergy and Infectious Diseases, Rocky Mountain Laboratory, Hamilton, Montana

In anticipation of the forthcoming catalog of Nearctic Diptera planned by Dr. Alan Stone and collaborators, and in part to provide further revisional data to my previous catalog of Tabanidae (Philip, 1947, 1950), the following comments and data are furnished. Many of these observations were facilitated by studies of pertinent collections in European museums, on grants from the American Philosophical Society in 1953, and the Marsh Fund of the National Academy of Sciences in 1958. New data on location or identity of types for this fauna are also included. In following text, British Museum (Natural History) is abbreviated to BMNH, U. S. National Museum to USNM, and holotypes are in the collection of the author (CBP); some other specimens are in the collection of L. L. Pechuman (LLP).

Apatolestes villosulus (Bigot)

Tabanus villosulus Bigot, 1892, Mem. Soc. Zool. Fr., *5:* 684. Type ♂, Calif., BMNH (seen in 1953, 1958).

Apatolestes villosulus. Philip, 1941, Bull. Brooklyn Ent. Soc. *36:* 196; 1954, Rev. Brasil. Ent., *2:* 23.

Apatolestes similis Brennan, 1935, Univ. Kans. Sci. Bull., *22:* 374. Type ♀, Los Angeles Co., Calif., USNM (seen 1949, 1959). Philip (1941, 1954, *op. cit.*). NEW SYNONYMY.

A restudy of the types in 1958–9 with more adequate series for comparison, in part supplied by Dr. L. L. Pechuman, is now convincing that the female of *A. similis* is properly associated with the male of *A. villosulus* as surmised in 1941. A pair taken

at the same time and place, Antioch, Calif. (collec. LLP), agrees with each type of appropriate sex, as do six other males from Contra Costa, San Bernardino, and Riverside Counties, and another female from Antioch, with minor variation in intensity of wing clouds, obscure brown shadings on notum and sides of abdomen, and prominence of pale-haired incisures. Scutellums are dark in all, not brown as in *A. parkeri.* A typographical error listed the length of *villosulus* type as " 18.5 mm." which should be corrected to 13.5 mm.

The obvious plasticity of characters in this genus make difficult the differentiation and keying of some species. The present synonymy emphasizes weaknesses in the 1954 key, and yellowing of the costal cells will not separate males of *villosulus* and *similis.* The apical palpal segments of two males are relatively shorter and stubbier than the type of *villosulus* (length to thickness as 1:2.7). There are apparent variants of even the genotypic species, *A. comastes* Will., which have distinct clouds on the cross veins, and intergradation between all gray, and dark banded abdomens. The genus is still in an unsatisfactory state for catalog purposes at this time.

Chrysops atricornis Bigot

1892, Mem. Soc. Zool. Fr., *5:* 603. Syntype ♂, ♀, " Colo," BMNH (seen 1953, 1958).

As material of the *furcata* group (Philip, 1935, 1955) continues to accumulate, especially from the north, the mutability of diagnostic characters becomes increasingly apparent. The same doubt of " Colorado " as source attaches to *C. atricornis* as to Bigot's *C. coloradensis;* the female types in BMNH probably, and the male syntype of the former certainly, came from California. Since the male belongs to and antedates *C. bishoppi* Brennan (Philip, 1941), it is imperative to establish the female syntype of *C. atricornis* as lectotype, though this will replace the name of the variant of *C. proclivis* described as subspecies *imfurcata* Philip with broad apical spot and no sublateral isolated spots on tergite 2. The type female of *atricornis* likewise has blackish fore coxae and broader front (index 1:0.9) with narrower callosity (crescentic and touching the eyes at the outer

corners) than in dark variants of *C. furcata* observed in Canada. None of the last in a considerable amount of material from south of the Canadian border has shown blackish fore coxae, nor have any *proclivis* had yellow ones. The broader fronts with more transverse callosities barely or nearly touching the eye margins plus the closer attainment of the hind wing margin by the cross-band assists in separating the *proclivis* complex from the dark variants of *furcata* assignable to variety *chagnoni* Philip.

Chrysops proclivis Osten Sacken

1877, U. S. Geol. Survey Bull. No. 3, p. 222.

A pair collected by Mr. Joe Schuh at the same time at Cornelius, Oregon, July 10, 1938, now permits confirmation that this complex, including the preceding variant, is distinct from *C. surda* Osten Sacken and that the two males from California and Washington described by me (1941) should actually be assigned to the latter as previously questioned. The female of the above pair is typical *C. proclivis* with black of the parafacials sharply limited by the sutures, and the arms of the geminate spot on tergite 2 are not divergent, though the sublateral spots are smaller than usual.

The male differs most strikingly from *C. surda* in having eyes as dichoptic as in the *pachycera* group and *C. hirsuticalla* Philip, but without swollen facial tubercles, the face widely yellow in the middle nearly to the sutures, the abdominal pattern above and below much more yellow, the incisures caudally more widely yellow, the dorsal row of sublateral spots completely separated on tergites 2 and 3, double geminate on 4, and hind legs yellow, blackened on basal two-thirds of femora. No midfacial pollinose stripe. The apical spot is a little widened in the middle but crosses only into the apical corner of cell R_4. Pechuman (correspondence) has a similar male of *proclivis* from Forest Grove, Oregon, 7 June 1938, which only differs in having facial yellow a little narrower and apical spot a little wider.

Chrysops excitans Walker

1850, Dipt. Saund., *1:* 72.

The type in BMNH from Nova Scotia agrees with the usual

concept of robust deerfly with broad red sides, geminate figure on tergite 2 not reaching hind margin and enclosing a large equilateral, yellowish gray triangle, and abbreviated crossband on the wing with outer convex margin. Both melanistic and much paler, predominantly reddish variations are encountered. Males are recorded as with entirely black bodies, though Pechuman (1949) describes a Michigan male with yellowish sides on the first two abdominal segments and "thick yellow pleural hairs." Though the species occurs across the entire northern states and Canada from Nova Scotia to Alaska, there is a puzzling population of small heretofore presumed variants centering in Michigan and radiating mainly to southern Ontario and through Wisconsin to Minnesota. Supposed intergradation has deterred recognition of this population which two males (including Pechuman's specimen above) now appear to warrant. Rearing is obviously desirable. This variant is distinguished by much smaller average size, the hour-glass-like marking on first two tergites solid to the hind margin, never with geminate spot on the second enclosing a distinct, equilateral, yellowish-gray pollinose triangle, and crossband with outer margin nearly straight, usually extending nearly to the hind margin of the wing. The two males from Michigan also show this wing character. Comparison of immature stages may confirm differences on a specific level.

Chrysops dawsoni n. sp.

A small species which has been considered a variant of *excitans* with, like it, no apical wing spot, a black face with three pollinose stripes, dark appendages, variable reddish sides on the first two tergites, but solid, median black figures on the first two tergites, upper margin of callosity usually straight, and crossband of wings less bowed and abbreviated. In a series of more than a hundred *excitans* taken together at Lake Itasca, Minnesota by Dr. Dawson, he was able to separate by casual inspection 13 of this form that had, in addition to smaller size, bronzed rather than blue-green eyes in fresh condition.

Holotype.—♀, 7.5 mm. Minneapolis, Minnesota, June 6, 1950, R. W. Dawson. In Coll. CBP through generosity of the collector

who has taken many interesting tabanids in various states and who was an inspiration to the writer while a student at the Universities of Nebraska and Minnesota. To him the species is gratefully dedicated.

Frontal callosity black transverse. Face and cheeks black with three yellow pollinose stripes, the median one incomplete. Scape and basal half of pedicel reddish, extreme bases of flagellums and palpi brown; remainder blackish. Thorax blackish, with an indistinct, median plumbeus band anteriorly, the shoulders brown, upper pleura and most vestiture yellowish. Legs black, the tibiae and tarsi reddish basally. Wings with hyaline apex, crossband broad not quite reaching posterior margin along vein M_3 and crossing more faintly the cubital cell, but a definite, narrow hyaline crescent at extreme base, the outer margin almost straight, basal cells hyaline across apical thirds. Halteres dark brown. Abdomen coal black with mostly sparse yellow hair, the outer thirds of tergites 1 and 2 sharply pale reddish, the median figure parallel sided, with a small median, yellow-haired, obsolescent, narrow pollinose triangle viewed from the rear. Venter black, the first two sternites laterally, and submedian spots on 3, yellowish.

Allotype.—♂, 6.5 mm. Cheboygan Co., Michigan, July 6, 1936, K. H. Kelley. In University of Michigan Museum.

Differs from the holotype in being more blackish over-all, including appendages, and more vestiture, the scapes, upper pleura, and narrow sides of tergite 2 brownish red. Median facial stripe complete to oral margin. Crossband nearly attaining hind margin, the outer margin also straight, base of cubital cell paler to a less extent, and hyaline spots in apices of basal spots narrower than in holotype.

Paratypes.—

Length 6.5–9 mm. Minnesota—2 ♀, Minneapolis; 6 ♀, Anoka Co., Coon and Rice Creeks, June 14 and 19, 1925, C. B. Philip; 13 ♀, Cedar Creek, Anoka Co., April–May 1950, G. B. Fairchild; ♀, Park Rapids, June 20, 1924, C. B. Philip; 2 ♀, Cook Co., August 22 and 30, 1926, L. W. Orr; ♀, Kinmount, June 8, 1934, D. Denning; ♀, Duluth, August 22, 1916; 2 ♀, Basswood Lake, Lake Co., August 16, 1920, J. W. Barnes; ♀, Floodwood, June 19, 1941, R. Knutson; 38 ♀, Itasca Park, various dates in June and July, 1930–50, R. W. Dawson; ♀, Stillwater, June 15, 1923, Berkeley Lewis (det. Hine as *C. excitans*); 6 ♀, Wanaska, June 27, 1957, R. L. Fischer. Wisconsin—♀, Villas Co., July 10, 1913. Michigan—2 ♂, Midland Co., May 28 and June 1, 1935, R. R. Dreisbach (1, LLP); 44 ♀, Cheboygan Co. including Douglas Lake (and 1 ♀ same data as allotype but July 5 (LLP)), various dates and collectors; ♀, Hendrick's Quarry, Luce Co., June 23, 1934; ♀, Ishpeming, Marquette Co., June 13, 1957, R. W. Hodges; ♀, Marquette Co., June 29, 1927, C. L. Hubbs; 22 ♀,

Negaumee, Marquette Co., June 15, and 2 ♀, Copper Harbor, Keweenaw Co., June 29, 1957, R. W. Hodges; 11 ♀, Alcona, Alger, Crawford, Mackinac, Marquette, Manistee, Missaukee, Mecosta, and Roscommon Counties, various dates in June 1951, 1953, 1955, and 1957, R. & K. Dreisbach; 4 ♀, Gogebic Co., Imp Lake, Cedar and Hope's Creeks, 30–31 May 1955, K. L. Hayes; 4 ♀, Schoolcraft Co., Floodwood, 6 and 21 July 1915, J. S. Rogers; ♀, Berrien Co., Harbert Dunes, August 1917, A. W. Andrews; 2 ♀, Montgomery Co., July 11, 1923, T. H. Hubbell; ♀, Dickenson Co., July 3, 1909; ♀, Cloquet, June 22, 1936, E. Fisher; ♀, Traverse City, June 19, 1937, C. W. Sabrosky; 6 ♀, West Branch, May 29, 1937; 2 ♀, Ewen, June 19, 1957, H. H. Axtell; 2 ♀, Bear Lake, June 21, 1940, C. W. Sabrosky. Ontario—♀, Miller Rapids Landing, August 24, 1957, R. W. Coleman; 4 ♀, Low Bush, Lake Abitibi, July 18 to August 12, 1925, N. K. Bigelow; 5 ♀, 40 mi. S. of Longlae, June 18 to July 20, 1951, and June 19, 1956, H. H. Axtell; 2 ♀, Ft. Severn, 56° N. Lat., July 7 and 15, 1940, C. E. Hope. Quebec—♀, Laniel, July 18, 1958, P. Benoit. In collections of the USNM, American Museum of Natural History, Michigan State University, Universities of Michigan and Minnesota, LLP, Brother Adrien Robert, and CBP.

Several Michigan and Ontario females with eye pattern relaxed, and several from alcohol studied by L. L. Pechumen (correspondence) showed the same reduction of the shaft of the arrowhead noted by the writer (1931) for Minnesota specimens differing from typical *C. excitans* in which the shaft is complete upward to the occipital margin. Most specimens also show a lightening of the infuscation in base of cubital cell not so marked as in most *C. carbonaria* Walker, which is lacking in the larger *C. excitans* (in which there is usually an excavation at cell R_5 in the convex outer margin). The same differences in wing pattern are found on comparison of the allotype with a male of *C. excitans* reared by Cameron from Douglas Lake, Manitoba, and the hyaline spots at apices of basal cells in latter are larger. In addition to the less distinct wing pattern with bowed crossband, the yellow on sides of the abdomen includes the edges of tergite 1 but does not reach the second incisure in *C. cuclux* Whitney male. Pechuman's paratype male of *dawsoni* differs from the allotype only in being a little larger in size, and the lateral red encroaching on the edges of tergite 1.

This species includes the 19 small Minnesota specimens mentioned by the writer (1931), and the amount of variation noted in *C. excitans* does not occur here, though one Itasca Park and

two Michigan specimens are more melanistic than the rest, the thorax entirely dark, and lateral reddish spots isolated in extreme edges of tergite 2. The Stillwater specimen is representative of several in which the median figure in first two tergites is narrow and hour-glass shaped. Rarely the lateral red may encroach onto tergite 3. In some others there is a tendency for extension of the black along the anterior incisure of tergite 2. When there is occasionally suggestion of an indistinct pollinose, median triangle on tergite 2 (as in the holotype), it is tall and much narrower than in *C. excitans*. Some specimens show a tendency for gentle bowing of the crossband without more definite triangle on tergite 2. The isolation of this population, though both species may be taken in the same locality, together with the distinctness of the male convinced me that it should be treated specifically rather than subspecifically. The only two specimens seen from very far outside this range that seem to agree with these characters are from White Fox, Sask., and Aklavik, N.W. Territory, Canada.

An anomalous series of specimens from Michigan and Wisconsin presents the abdominal patterns of *C. cuclux* Whitney but a much darker wing pattern with bowed, abbreviated crossband and tendency for fading of the infuscation at extreme base of cubital cell.

Chrysops moerens var. confusa Krober

1926, Stettin Ent. Ztg., *87:* 284.

Brennan (1935) considered this a variant of *C. callida* O.S. rather than *C. aestuans* van der Wulp (syn. *moerens* Walker), but it was cataloged by me (1947) under the latter species. However, study of the type from Oliver, British Columbia in Canadian National Museum reveals that it has the narrower, more convergent front and taller callosity of *C. callida* Osten Sacken with which species Brennan was therefore correct in associating *confusa*. Though the sublateral spots on sides of tergite 2 are missing, tergites 3 and 4 have the usual double geminate pattern. The female from Yakima, Washington, reported by me (1941) agrees in frontal characters but further lacks the lateral spots on tergites 3 and 4. It is likely that the specimen of *C.*

callida reported by Williston (1887) from "Washington Territory" with reduced abdominal pattern is also *confusa*.

Another female from South Dakota has a similarly very reduced abdominal pattern, but the frontal characters and paler apical spots of the wings relate to *C. aestuans* more clearly than to *C. callida* and is described below, thus providing the parallel situation under *aestuans*. Pechuman (1949) has called attention to variation and intergradation in the "*callida* complex" and suggests that the shape of the frontal callosity is the most useful differential character.

Chrysops aestuans pseudoconfusa n. var.

Holotype.—♀, 9 mm. Vivian, South Dakota, Reed's Ranch, July 11, 1940, H. C. Severin.

Differs from the typical form in the following respects: The maculations on the abdomen are reduced to an inverted "V" on tergite 2, and to paired inverted submedian triangles reaching only half across tergites 3 and 4 with no lateral spots; the incisures on the following tergites are more widely yellow. Sternite 3 is entirely yellow. The legs are yellow except for darkened knees and apices of the fore tibiae. The front agrees in being about as tall as wide, and but little narrowed above, and the callosity is wide and shallow.

Chrysops bishoppi gilva n. var.

A very pallid form of the somewhat variable species in which the wing and abdominal patterns are very reduced, and the ocellar tubercle at vertex much more pollinose.

Holotype.—♀, 9 mm. Big Pine Creek, Inyo Co., California. 4500 ft., June 13, 1942, R. Bohart.

Differs from typical form as follows: Ocellar tubercle dark gray pollinose with four small, black, bare spots at the corners outside the three ocelli. Thorax paler gray with the dark stripes on notum and pleura narrower; in the typical form the dark and gray stripes are subequal. Scutellum with dull pinkish posterior margin. The crossband of the wings is even more dilute with base of cell R_5 and most of the discal cell hardly darker than the tinting of the hyaline triangle; first basal cell with nearly the apical half similarly subhyaline. Middorsal dark spot on tergite 1 reduced and widely separated from hind margin, and the geminate spot on tergite 2 much smaller, nearly divided basally, and terminating about one third distance from the hind margin; in the typical form this appears to be a con-

tinuous figure on the two tergites. Tergites 3 to 7 chiefly pale yellow with very narrow basal maculations which on 3 and 4 consist of four narrow spots. Sternites 2 to 4 entirely pale yellow except for a very small, median spot at base of 2 which is contiguous to a small, apical one on the first tergite. Basal bands on sternites 5 and 6 narrow.

Paratype.—♀, same data.

Differs from holotype only in lack of pinkish apex of scutellum, and spots on ocellar tubercle and base of sternite 2 a little larger.

Except for the very pallid color and pink-tipped scutellum, intergradations with the darker typical forms are found in most of the above characters though the figure on the first two tergites is always heavier and solid in appearance.

Chrysops cincticornis Walker

1848, List Dipt., *1:* 201.

Chrysops celer Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., *2:* 376. NEW SYNONYMY.

Brennan (1935) considered this an unrecognizable species. The type in BMNH from "locality unknown," agrees closely with specimens from Massachusetts and Connecticut previously compared with *C. celer* which thus becomes a synonym, unfortunately for this well-known name.

Chrysops nigripes Zetterstedt

1840, Inst. Lapp., p. 519. Kono and Takahasi, 1939, Insecta Matsumurana, *13:* 149.

I had previously (1947) cataloged *C. nigricornis* Matsumura of Japan as a synonym of the above following Olsoufiev (1937) and others, though Kröber (1939) listed it as a variety. However, Kono and Takahasi (*op. cit.*) have pointed out that the type agrees, rather, with *C. makerowi* Pleske, a quite different Siberian species. I have been unable to locate Matsumura's type in recent correspondence but his name will be dropped from synonymy with *C. nigripes.*

The outer wing pattern in *C. nigripes* from Montana, Alberta, Alaska, and Manchuria (Philip, 1956) shows considerable variation in width of the apical spot and extent of the projection at the fork, but all have the typical abdominal pattern and black

legs. *C. makerowi* has not, apparently, crossed the Behring Strait.

Chrysops parvula Daecke

1907, Ent. News, *18:* 142.

There are two syntype females from Bamber, New Jersey, 1906, in BMNH.

Chrysops obsoleta Wiedemann

1821, Dipt. Exot., *1:* 108.

Chrysops trinotata Macquart, 1838, Dipt. Exot., *1:* p. 161.

The type of *trinotata* in BMNH now lacks flagellums and abdomen but the thoracic lines, though discolored, agree with my female previously compared with the type of *C. obsoleta* Wiedemann removing doubt of synonymy in my catalog (1947) and of location of type of *trinotata.*

Chrysops hinei Daecke

1907, Ent. News, *18:* 143.

There is one syntype female in BMNH from Atlantic City, New Jersey, August 7.

Chrysops bistellata Daecke

1905, Ent. News, *16:* 249.

One topotypic, syntype female is in BMNH.

Chrysops virgulata Bellardi

1859, Saggio Ditter. Messi Co., *1:* 71.

The type male labelled " Cuantla E. T.," in Turin Museum is in poor condition, moldy, and with missing flagellums but agreed with a compared specimen from Guadalajara, Mexico, of the species as now recognized. The species crosses the border into the southwestern United States.

Chrysops carbonaria Walker

1848, List Dipt., *1:* 203.

Chrysops atra Macquart, 1850, Dipt. Exot., Suppl. IV, p. 344.

The type of C. atra from New Foundland, thought to be lost but discovered in Paris Museum with label " atra " in Macquart's

hand, agrees with my homotype of *C. fugax* Osten Sacken and the doubt on synonymy with *C. carbonaria* Walker is thus removed. *C. atra* represents the form with bowed, abbreviated crossband, and deep yellow pleural hairs.

Chrysops nigra Macquart

1838, Dipt. Exot., *1:* p. 165.

In addition to the type cataloged at Lille, three syntypes were found in Paris Museum from " Amer. du Nord."

Chrysops vittatus Wiedemann

1821, Dipt. Exot., *1:* 106.

Chrysops lineatus Jaennicke, 1867, Neue Exot. Dipt., *6:* 334.

The type female of *C. lineatus* from Illinois in Frankfurt Museum agrees with my topotype of *C. vittatus* Wiedemann as presently synonymized.

Chrysops flavida Wiedemann

1821, Dipt. Exot., *1:* 105. Type ♀, Savannah, Ga., Copenhagen Mus. (seen in 1953).

Chrysops pallidus Macquart, 1838, Dipt. Exot., *1:* 166.
Chrysops pallidus Bellardi, 1858, Saggio Ditter. Messi, *1:* 73.

The two specimens described by Macquart are in Paris Museum from " Patria ignota, peut etre France." The second headless specimen now bears the type label and is recognizable as the typical form of the prior *C. flavida* Wiedemann though there is additional pest damage. In spite of the fact that the description, including head characters, applies mainly to the other unlabelled female on a short pin, the headless specimen is selected as lectotype to preserve the well-known but later described *C. brunnea* Hine with which the complete syntype agrees. A later *C. pallidus* by Bellardi from Mexico is also a synonym of *C. flavida* Wiedemann (Philip, 1955, p. 104, type in Turin).

Chrysops wiedemanni Krober

1926, Stettin Ent. Zeit., *87:* 267.

Syntypes in Hamburg were casualties of the war, but one intact syntype female remaining in Canadian National Collection

is available as lectotype. It is labelled " Fort Coulonge, Que. 3/7/19 S. A. Graham, paratype no. 2493."

Other species.—Presence in Vienna Museum, and present conception of each species, was confirmed for Wiedemann's types of *C. lateralis, C. geminatus, C. obsoletus* and for *C. fraternus* Kröber (= *wiedemanni* Kröber ♂).

Whitney's tabanid types are either destroyed or are scattered in various institutions. Following are species regarding which new data are available since cataloged in 1947: *Chrysops cuclux,* listed as " BMNH ? " but a specimen in Boston Society of Natural History Collection is apparently the only valid surviving syntype (Philip, 1942); *C. cursim,* none of the original six syntypes has ever been found in any of the several repositories of Whitney types; *C. nigribimbo,* one of two syntypes in Museum of Comparative Zoology no. 4023 labelled " Milford, N. Hamp., 6.9 " is designated as lectotype; another syntype of same data has been transferred from BSNH to Boston University; *T. superjumentarius,* because of destruction of the two syntypes, I designated (1950) as " neotype " a specimen in California Academy of Sciences which was identified by Whitney from the type locality. There may be question of the legitimacy of this designation under the new Rules regarding neotypes.

Merycomyia whitneyi (Johnson)

Tabanus whitneyi Johnson, 1904, Psyche, *11:* 15.

Both sexes were originally described without type designation. Of a syntype pair now present in MCZ, the male bears two type labels, one MCZ no. 14523. Probably Stone (1938) was influenced by this in referring to the female as " allotype." To formalize this reference, the male is herewith designated as lectotype.

Diachlorus ferrugatus (Fabricius)

Chrysops ferrugatus Fabricius, 1805, Syst. Antl., p. 111.

The location of the type remains unknown. It was not found among the Fabrician types in Copenhagen Museum or the Kiel Collection on extended loan there. Two syntype females of synonym *Tabanus rondanii* Bellardi from Mexico in Turin Mu-

seum, the single types of *Diabasis ataenia* Macquart from "Carolina" in Paris Museum (previously questioned), of *Chrysops convergens* Walker from Honduras and of *C. approximans* Walker from Florida, both in BMNH, all agree with a specimen compared from North Carolina.

Atylotus bicolor (Wiedemann)

Tabanus bicolor Wiedemann, 1821, Dipt. Exot., *1:* 96.

Two syntype males of this important genotype species are in Vienna Museum, "Pennsyl. Coll. Winthem," in fair condition including one complete antenna on each. They agree with present conception of the species.

Atylotus pemeticus (Johnson)

Tabanus pemeticus Johnson, 1921, Boston Soc. Nat. Hist. Occas. Pap., *5:* 11.

The type female has now been transferred from Boston Society of Natural History to Museum of Comparative Zoology, no. 7524.

Atylotus duplex (Walker)

Tabanus duplex Walker, 1854, List. Dipt., V, Suppl. 1, p. 173 (change of name).
Tabanus imitans Walker, 1848, List Dipt., *1:* 173.

This dark species was listed as unrecognizable by Stone (1938). The syntype male and female from St. Martin's Falls, Canada, in BMNH are in good condition, and females from Ontario were found to agree in 1958. The male has a very large head due to a wide band of small facets along the occipital margin to the vertex, and no available males agreed closely. Because of this unusual character and better availability of females, the female is designated as lectotype.

Specimens of the dark form, in part from Drs. J. F. McAlpine and L. L. Pechuman, have been seen from Alberta, Manitoba, Ontario, Quebec, and northern Michigan.

Tabanus atratus Fabricius

1775, Syst. Ent., p. 789.

Tabanus validus Wiedemann, 1828, Auss. Zweifl. Ins., *1:* 113.

Fragments of two syntypes of *T. validus* remain in the Kiel Collection which are, however, sufficient to confirm present synonymy.

Tabanus nigripes Wiedemann

1821, Dipt. Exot., *1:* 75.

Tabanus coffeatus Macquart, 1847, Dipt. Exot., Suppl. 2, p. 39.

Presence of the type male in Copenhagen Museum, and synonymy of *T. coffeatus* Macquart (type ♂ in BMNH) were confirmed by comparison of specimens.

Tabanus melanocerus Wiedemann

1828, Auss. Zweifl. Ins., *1:* 122.

The type was cataloged as in Vienna Museum but was not seen there in 1953. The same is true of the types of *T. reinwardtii* Wiedemann and *Hybomitra trispila* (Wiedemann); since the former is a patronym of Reinwardt, the name should be written *reinwardti* in conformity with zoological practice.

Tabanus dorsonotatus Macquart

1847, Dipt. Exot., Suppl. 2, p. 22.

Though reported to be from North Carolina and previously synonymized with *T. fumipennis* Wiedemann, no certain type was located in BMNH. There is, however, a large (22 mm.) male bearing a label in Macquart's hand "dorsomaculata," another label by Bigot "Carol. Nord, Dipt. Exot.," and a third by Oldroyd "Only Macq. sp. of this name is from Algeria." Osten Sacken (1878) believed this to be the actual type of *dorsonotatus*. If there has been a confusion of names and localities for this specimen, it is not *T. fumipennis* on account of dark antennae and femora. Traces of pale triangles on the worn, reddish abdomen and moderately narrowed cell R_5 suggested *T. sulcifrons* Macquart except for lack of both of wing spots and markedly enlarged upper eye facets. I suspect that this specimen, at least, is not of Nearctic origin, and also returns the species, *T. dorsonotatus* to status of an unrecognized species where Stone (1938) placed it.

Tabanus derivatus Walker

1848, List Dipt., *1:* 151.

The type in BMNH is a large, headless male (body 16.5 mm.) reported to be from " N. America ex coll. Children " which Fairchild (1956) suggested might be a *Lophotabanus* but the tinted wings with long spur veins, no evidence of dark prescutellar spots, and unicolorous, orange-reddish abdomen seems closer to Neotropical *Macrocormus*. The name is definitely not of concern in a Nearctic catalog.

Tabanus calens Linnaeus

1767, Syst. Nat., ed. 12, *1:* 1000.

There are two females in Paris Museum, probably from original Bosc Collections, which are labelled types from " Amer. du Nord " of *T. lineatus* Fabricius which agree with *T. calens* though worn. These had been cataloged (1947) as in " collection unknown."

Tabanus crassicornis Wiedemann

1821, Dipt. Exot., *1:* 71.

Stone (1938) listed this as an unrecognized species from " America ?." The type was discovered in the Kiel Collection now at Copenhagen which Wiedemann recognized as misidentified with the East Indian *T. rufiventris* Fabricius, and a label, *crassicornis*, is still on the specimen. It is a *Chelotabanus* related to *T. albibarbis* Wiedemann and therefore Neotropical, not Nearctic.

Tabanus colombensis Macquart

1844, Dipt. Exot., Suppl. 1, p. 165.

Tabanus amplifrons Kröber, 1933, Rev. Ent., *3:* 354.

The type of *amplifrons*, originally in Munich Museum, was not present with other Kröber specimens that survived war damage, and so must be presumed a casualty. Fairchild (1956) has provided the synonymy.

Tabanus abdominalis Fabricius

1805, Syst. Antl., p. 96. Osten Sacken, 1876, Mem. Bost. Soc. Nat. Hist., *2:* 434.

Tabanus limbatinervis Macquart, 1847, Dipt. Exot., Suppl. 2, p. 32. NEW SYNONYMY.

Type female of *limbatinervis* in BMNH labelled Tasmania, questioned for that fauna by Dr. I. M. Mackerras, proves to be a synonym of the Nearctic *T. abdominalis*. The narrow front, and closed cell R_5 with other characters agreed with other U. S. specimens in BMNH. The two syntypes of *T. abdominalis* in Paris Museum from original Bosc Collection, mentioned by Osten Sacken (1878) and Philip (1950), are the form of this complex with bright orange abdomens and reduced median spots, plus closed cell R_5.

Fragments of three other specimens labelled types of *T. abdominalis* were seen in the Kiel Collection in 1953, but their authenticity may be questionable, and possibly were so-labelled as a result of redescription by Wiedemann as discussed by Osten Sacken (1876). Only one of the Kiel specimens is identifiable by a wing remaining. The narrowed but open cell R_5 and moderate wing spots agree with *sulcifrons*, but the spots are not as heavy nor does the membrane have the whitish cast that is seen on the remains of the type of *T. variegatus* Fabricius in the same collection; cell R_5 is the same. There is an earlier *T. variegatus* DeGeer.

Tabanus similis Macquart

1849, Dipt. Exot., Suppl. 4, p. 335 (Tasmania).

Tabanus lineola subsp. *scutellaris* Walker, 1850, Ins. Saund. Dipt., *1:* 27. NEW SYNONYMY.

Type ♀ in poor condition in BMNH and also questioned from Tasmania by Dr. Mackerras, is a worn specimen of the Nearctic *T. lineola scutellaris* Walker. The wide front, quadrate callosity, red femora and scutellar margin, and lined abdomen characterize it. Since Macquart's name has priority by a few months, the name of one of our most widespread horseflies thus falls by synonymy. As concurred in by Dr. Pechuman, this form is so distinct with no intergradation with *T. lineola* Fabricius, continued maintenance as a subspecies is not justified.

Tabanus quinquevittatus Wiedemann

1821, Dipt. Exot., *1:* 84.

Tabanus manifestus Walker, 1850, Ins. Saund. Dipt., *1:* 41. NEW SYNONYMY.

Type ♀ of *manifestus* " ? S. America," in BMNH is the same as *T. quinquevittatus* of North America also providing new synonymy. On the other hand, comparison of specimens with the type of *T. vicarius* Walker in BMNH proves this to be a synonym of *T. nigrovittatus* Macquart not of *T. quinquevittatus*.

The possible type ♀ of *T. nigrovittatus*, previously listed as location unknown, was recently found in BMNH by Mr. Oldroyd who writes, " It has the usual label in Macquart's writing, stuck on to a bigger one by Bigot. Bigot has written ' Nova Scotia,' and a small, separate label, in old writing, says ' Panama '; but the original description says ' on the banks of the Amazons '! The specimen is falling apart, but seems to be larger and blacker than the series of *simulans* with which it stands." Further study will therefore be necessary to decide if the present conception agrees.

Tabanus fusconervosus Macquart

1838, Dipt. Exot., *1:* 151.

Tabanus recedens Walker, 1848, List Dipt., *1:* 147. NEW SYNONYMY.

T. fusconervosus has been synonymized with question under *T. turbidus* Wiedemann. However, comparison of the type in Paris Museum from " Patrie inconnu " with a homotype of *T. recedens* Walker (1848, not 1854), *T. confusus* Walker, and *T. fur* Williston (1887, not 1901) shows all to belong to the same species which again necessitates unfortunate replacement of a well-established name. There is also in Paris Museum another specimen with Macquart's manuscript label *T. " fuscinervis "* from " Cap? " (Cape of Good Hope) which appears to be the same but was never published.

Tabanus turbidus Wiedemann

1828, Auss. Zweifl. Ins., *1:* 124.

The type " aus Kentucky " (8½ lines) is supposed to be in Vienna Museum but was not seen by me. Instead, at present, there are two females labelled types from " Savannah " which do not fit the description but are the same as the previously confused *T. aar* Philip, a coastal species not known inland toward

Kentucky. The two specimens are larger (19.5 and 22 mm.) and also differ from the description in having unpatterned thoraxes and abdomens, and wings only tinted without accentuation along the vein margins. The larger carries the usual Museum green type label with " turbidus Wied. Savannah " not in Wiedemann's handwriting. These, therefore, cannot be types. On the other hand, a third specimen from New Orleans not labelled type, but possibly seen by Wiedemann at a later date, is characteristic of *turbidus* with more evident lines on the thorax, abdominal pattern, and margined wing veins. The true type was not seen among Wiedemann specimens at Copenhagen, Frankfurt, or Munich, nor is it in Berlin according to Prof. Fritz Peus, and must remain as in collection unknown.

The possibility that *T. aar* is preoccupied by the unrecognized *T. ferrugineus* Palisot from United States is now unimportant because of two earlier such names by Strom and Thünberg which were overlooked in Surcouf's catalog (1921).

Tabanus guttatus Wiedemann

1821, Dipt. Exot., *1:* 73.

This species described from " America " was listed by Stone (1938) as unrecognizable. Neither the type, originally stated to be in " Prof. Germar's Museum in Halle," nor the Germar Collection are in Halle at the present time according to a note from Prof. J. O. Husing of Halle through Prof. Fritz Peus of Berlin, and the type is not to be found with Wiedemann's types in other European museums. However, its identity is not important since there is a prior *Tabanus* (now *Scaptia*) *guttatus* Donovan in Australia.

Tabanus marginalis Fabricius

1805, Syst. Antl., p. 99.

Tabanus nivosus Osten Sacken, 1876, Mem. Bost. Soc. Nat. Hist., *2:* 445. NEW SYNONYMY.

This is another species listed as unrecognizable by Stone (1938), and another unfortunate preoccupation of a well-known Nearctic name now becomes evident. The type of *marginalis* from North America in Copenhagen has been damaged by a

museum pest, but remains of the front and median callosity, abdominal pattern with large lateral and small median spots, legs and halteres agree with a homotype of *T. nivosus* in contrast to *T. vivax* Osten Sacken, *T. fairchildi* Stone, and *T. fulvicallus* Philip, also compared.

Tabanus cheliopterus Rondani

1850, Nuovi Ann. Stor. Bologna, *3*(3): 192.

Tabanus fronto subsp. *subfronto* Philip, 1936, J. Kans. Ent. Soc., *9:* 100. NEW SYNONYMY.

The type ♀ of *cheliopterus* from "Carolina" was seen in Turin Museum, and is the pale form with reddish body and legs including fore femora that I described as subspecies *subfronto*. Revival of supposed synonym *fronto* Osten Sacken as a subspecies is therefore indicated. The astuteness of Osten Sacken's early, careful observations is again demonstrated in not relating this when he described *T. fronto*.

Tabanus novaescotiae Macquart

1847, Dipt. Exot., Suppl. 3, p. 180.

Tabanus actaeon Osten Sacken, 1876, Mem. Bost. Soc. Nat. Hist., *2:* 443.

From the time of Osten Sacken, *T. novaescotiae* has been associated with doubt with the later, well-known *T. actaeon* Osten Sacken (Philip, 1941). Comparison of my homotype of *T. actaeon* with the type in BMNH removes the doubt, and causes replacement of another well-known name. The original spelling "*novae-scoeiae*" is meaningless and may be presumed to be a typographical error (especially since Macquart's index also corrects the spelling), but the hyphen is not to be maintained under the Rules.

Hybomitra fulvilateralis (Macquart)

Tabanus fulvilateralis Macquart, 1838, Dipt. Exot., *1:* 137. Type ♀, "Cayenne," Paris Mus. (seen 1958).

Tabanus recedens Walker, 1854, List Dipt., V, Suppl. 1, p. 201. Type ♀, West Coast Amer., BMNH (seen 1953, 1958). Not Walker, 1848, List Dipt., *1:* 147. NEW SYNONYMY.

Tabanus haemaphora Marten, 1882, Canad. Ent., *14:* 210. Syntype ♀, Calif. (destroyed). NEW SYNONYMY.

Hybomitra haemaphora Philip, 1947, Amer. Mid. Nat., *37:* 294.

Discovery that the type of *fulvilateralis* in Paris, which had been mislabelled from Cayenne, bears the prior name for this now well-established species is most unfortunate. This misfortune would have been a good candidate for an action on conservation had the new Rules been in effect. *T. recedens* Walker (1854, not 1848) has heretofore been wrongly synonymized under *H. captonis* (Marten).

Hybomitra zonalis (Kirby)

Tabanus zonalis Kirby, 1837, Fauna Bor.-Amer., *4:* 314.
Hybomitra zonalis. Philip, 1947, Amer. Mid. Nat., *37:* 300.

The type female of *Tabanus flavocinctus* Bellardi was found in Turin Museum and has been correctly synonymized even though Mexico would be an unusual locality for this species. The specimen itself carries no locality label but there is a cabinet label "Mexico, Salle."

Hybomitra aurilimba (Stone)

Tabanus aurilimbus Stone, 1938, U.S.D.A. Misc. Publ., No. 305, p. 130.
Hybomitra aurilimba. Philip, 1942, Proc. N. Eng. Zool. Club, 21: 59; 1954, Ann. Ent. Soc. Amer., *47:* 31.
Tabanus (*Hybomitra*) *affinis aurilimbus.* Pechuman, 1955, Bull. Brooklyn Ent. Soc., *50:* 65.

Males of this species are not uncommon in collections of the North Atlantic Coast States and Pechuman (*op. cit.*) reports seeing many. I have males from Pa., N. J., N. Y., Conn., Mass., Vt., N. H., Me., Que., and N. Bruns., but to date the only males of *H. affinis* (Kirby) reported in western well-collected areas are the eight I took (1931) at a "road-side puddle," near International Falls, Minn. (along with males of *H. zonalis* Kirby), plus three from Itaska Park, Minn., taken later by R. W. Dawson. These differ consistently from the New England specimens in the darker, more excised antennal plates, and wider abdominal middorsal black stripe, no yellow-haired, sublateral triangles, and midventral quadrate spots on the first two tergites. Intergradation in these characters in females from western areas prevents their satisfactory separation, and I have a female from Minnesota and Alaska which have extensive golden hairs basally on the hind-tibial fringes, and on sublateral triangles.

Chapman (1954) took more *H. zonalis* on a bald mountain top in western Montana than any other tabanid species between May and September 1952. I have been collecting from such locations for over two decades but neither of us has captured *H. affinis* (Kirby), though females are present on stock in the valleys. On the other hand, Stone (1938) reports taking a number of males (undoubtedly *aurilimba*) on a Connecticut mountain top. The differences in habits and habitus of the males constrain me to consider the two forms as specifically distinct as is *H. gracilipalpis* (Hine), in spite of the difficulty of separation of the females. Until males are available to confirm it, presence of *H. aurilimba* from Michigan west must be accepted with reservation, though they undoubtedly overlap in at least eastern Canada.

Males of *H. trepida* (McDunnough), with which I at first confused these, differ in having the area of upper eye facets perceptibly enlarged with a buff lower border, the plates a little less excised, and apical palpal segments a little shorter and more cylindrical than ovoid. Both have sublateral, yellow-haired triangles.

Hybomitra sexfasciata (Hine)

Tabanus sexfasciatus Hine, 1923, Canad. Ent., *55:* 144. Type ♀, Camp 334, Alaska, USNM (studied in 1949). Stone, 1935, Proc. Ent. Soc. Wash., *37:* 18 (synonymy).

Tabanus borealis of authors, not Fabricius.

Tabanus (*Tylostypia*) *borealis* subsp. *anderi* Kauri, 1951, Opuscula Entomologica, *16:* 101.

Hybomitra sexfasciata. Philip, 1947, Amer. Mid. Nat., *37:* 298; Jap. J. Sanitary Zool., *7:* 229 (synonymy).

The unaccountable confusion of this holarctic species with *H. borealis* of authors, not Fabricius, crediting Loew or Meigen, and with *H. lapponica* (Wahlberg), has in part been reviewed by Stone (1935) who considered that the boreal, Nearctic *H. sexfasciata* (Hine) was different from Fabricius' Palaearctic species. Subsequently, Olsoufiev (1937), Kröber (1939), and others differentiated *H. lapponica* from *H. borealis* on smaller size and narrower front in the females, but the latter inexplicably synonymized *H. borealis* (Fabricius, 1781) under *H. lapponica* (Walker, 1848) while crediting *H. borealis* to Loew 1858, as have some

other authors. Unfortunately, only the thorax with reddish antealar tubercles, and wings with yellow costal cells are all that remain of Fabricius' type in the Kiel Collection which precludes adequate comparison with Wahlberg's type, presumably in Stockholm. Kauri (1951) had accepted this later interpretation of *H. borealis* when he described his subspecies *anderi* from Scandinavia, but he has confirmed (correspondence) that this is the same as *sexfasciata* (Hine). The fragments of Fabricius' type of *borealis* with red antealar tubercles confirm Stone's (*op. cit.*) declaration that the two are not specifically related, though the *borealis* of authors is the same.

It is remarkable that while *H. sexfasciata* extends from Alaska to Labrador in boreal America, and crosses into Scandinavia, the related *H. lapponica* occurs from Scandinavia to Manchuria and Hokkaido (Kono and Takahasi, 1939) across boreal Europe and Asia, without invading the Nearctic fauna so far as known.

Hybomitra (?) vicinus (Macquart)

Tabanus vicinus Macquart, 1838, Dipt. Exot., *1:* 147. Stone, 1938, USDA Misc. Publ. No. 305, p. 167 (unrecognized species). Philip, 1941, Canad. Ent., *73:* 152 (*Hybomitra* ?).

The type of this still unrecognized species reported from "Carolina" remains unlocated. The description, including comparison to *T. luridus* of Europe, give the impression of a small, red-sided *Hybomitra* with perhaps bare subcallus, but fits neither *H. difficilis* (Macquart) nor *H. hinei* (Johnson). Four specimens (det. ?) under the name in BMNH are all *H. rhombica osburni* (Hine).

Stenotabanus guttatulus (Townsend)

Diachlorus guttatulus Townsend, 1893, Trans. Kan. Acad. Sci., *13:* 134. Syntype females, 7 from Las Cruces, New Mexico.

Tabanus cribellum Hine, 1904, Ohio Nat., *5:* 236. Philip, 1941, Canad. Ent., *73:* 11 (♂). Not Osten Sacken, 1886, Biol. Centr.-Amer. Insec., Dipt., *1:* 52.

Stenotabanus cribellum Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 36. Philip, 1950, Amer. Mid. Nat., *43:* 435.

Students of Nearctic Tabanidae have followed Hine (*op. cit.*) in synonymizing these two unusual species, but study in BMNH

in 1958 of Osten Sacken's types from Presidio, Mexico, unexpectedly revealed that *S. cribellum* is actually the prior name for the recently described *S. currani* Philip (1954, Amer. Mus. Nov. No. 1695, p. 20) from Nyarit, Mexico, thus reinstating *S. guttatulus* for the Nearctic species from the Southwest. The allotype male of *S. currani* thus becomes allotype for the previously unknown, true male of *S. cribellum*, while the supposed male of the latter (Philip, 1941) becomes the allotype of *S. guttatulus*.

There are two of the original three syntypes of *S. cribellum* in the BMNH, plus a badly soiled syntype of *S. guttatulus* among the Brunnetti accessions. There are also a syntype each of the latter in collections of Ohio State University and USNM, plus four at Kansas University of which the best preserved at Kansas University is herewith designated as lectotype.

New Distributional Records

Specimens have been seen from the following new states and provinces from various collectors and sources:

Stonemyia tranquilla fera (Will.), *Alta., N. J.; *Chrysops aberrans* Phil., *N. B.; *C. dimmocki* Hine, Ohio (prev. record overlooked); *C. geminata* Wied., Wisc.; *C. nigribimbo* Whit., *Md., S. Car.; *C. mitis* O.S., *N.W. Terr., *N. Bruns., *Nfld., W. Va.; *C. cincticornis* Walk. (syn. *celere* O.S.), Ala.; *C. pachycera hungerfordi* Bren., *Calif.; *C. shermani* Hine, *N. B.; *Merycomyia whitneyi* (Jhns.), *N. Car., Ohio; *Glaucops fratellus* (Will.), Sask.; *Atylotus incisuralis* (Macq.), *Man., *N. Dak., *Ariz. and *A. tingaureus* Phil., B. C. (males from Alaska confirm distinctness of this variant); *Hybomitra aatos* Phil., *Ariz., Utah; *H. affinis* (Kirby), *Yukon, *N.W. Terr., *N. Brun., *N. Scot., Labr.; *H. astuta* (O.S.), Alas.; *H. californica* (Mart.), *Ida.; *H. captonis* (Mart.), *Yukon; *H. fulvilateralis* Macq. (syn. *haemaphora* Mart.), *Alta., *N. Mex., Ariz.; *H. lasiophthalma* (Macq.), Oakwood, Leon Co., Texas (3 ♀); *H. affinis aurilimba* (Stone), N.F., *Vt., Que.; *H. daeckei* (Hine), *Md., *S. Car., Ga.; *H. gracilipalpis* (Hine), *N.W. Terr., Ont., Me.; *H. tetrica* (Mart.), *Man., *Ont., *S. Dak., *Ore., Sask.; *H. typha* (O.S.), *Lab., *Ohio, *N. Dak., Ida.; *Tabanus atratus fulvopilosus* Johns., *N. J. and *nantuckensis* Hine, *N. C.; *T. catenatus* Walk., *N. S.; *Tabanus equalis* Hine, Fla.; *T. fairchildi* Stone, *N. Scot.; *T. gilanus* Twns., *Colo.; *T. gladiator* Stone, *Tenn.; *T. similis* Macq. (Syn. *scutellaris* Walk.), *N. Brun., *Vt., Ariz.; *T. molestus* Say, *Ohio, Okla.; *T. kesseli* Phil., Wyo.; *T. marginalis* Fabr. (syn. *nivosus* O.S.), Ida.; *T. pumilus* Macq., *Ont., *Ohio; *T. superjumenterius* Whit., *Man., *Ark.;

T. reinwardti Wied., *Texas; *T. sackeni* Fchld., *N. H., *N. J., *Md., *W. Va., *N. Car.; *T. sparus* Whit., *S. Car., *Kan., *Tex.; *T. stonei* Phil., *Ariz., *Tex.; *T. sublongus* Stone, W. Va., *N. Car.; *T. zythicolor* Phil., *N. J.; and *T. vittiger schwardti* Phil., *Pa.

Three records not cataloged in 1947 which were questioned earlier by Stone (1938) and not subsequently confirmed, were: *A. bicolor* Wied., ? N. Mex., *H. atrobasis* (McDun.), ? N. Mex., and *T. gilanus* Twns., ? Colo. New records have been published for Tennessee and Canada by Pechuman (1954, 1957), for Pennsylvania by Frost and Pechuman (1958), for Michigan by Hays (1956), and for Wisconsin by Roberts and Dicke (1958).

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THE LIFE HISTORY OF TANYPTERYX HAGENI SELYS (ODONATA)

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The modern Petaluridae is the smallest family in the sub-order Anisoptera and contains but eight living species belonging to five genera. This family, of which *Tanypteryx hageni* is one species, is a remnant of a great Petalurid fauna that flourished on earth in Solenhofen and Jurassic times. The abundance of their fossils shows that they were the dominant dragon flies of the world. That the species now in existence are the relicts of this once widespread and flourishing fauna is indicated by their spotted distribution throughout the world, i.e., *Tachopteryx thoreyi* in eastern United States, *Tanypteryx hageni* in western North America, *Tanypteryx pryeri* in Japan, *Phenes raptor* in Chile, *Uropetala carovei* in New Zealand, *Petalura gigantea, P. pulcherrima* and *P. ingentissima* in Australia.

Up to the present time fairly documented life history studies have been made of only two of the species, *Petalura gigantea* by Tillyard (1909, 1911) and *Uropetala carovei* by Wolfe (1953). Brief notes have been published on the habits of *Tachopteryx thoreyi* by Williamson (1900, 1901), Byers (1930), and Fisher (1940); of *Phenes raptor* by Joseph (1929); of *Tanypteryx hageni* by Whitney (1947), and Smith and Pritchard (1956); and of *Tanypteryx pryeri* by Asahina (1949) and Taketo (1958).

For the past four years a study of the life habits and distribution of *Tanypteryx hageni* Selys in Washington and Oregon has been in progress. Observations and life history notes were made of this rare and interesting dragon fly chiefly in the vicinity of Tipsoo Lake, Mt. Rainier National Park, Washington and at Still Creek Forest Camp (the "Swim" of Mrs. Whitney) Mt. Hood region of Oregon. Specimens have been collected at both of these places as well as in the Olympic Mountains, Washington, in the region of the Dosewalips River divide.

Although there are a number of systematic and collection notes published regarding this species (Kennedy, 1917; Walker and Rieker, 1938; Whitehouse, 1941; Smith and Pritchard, 1956; and Fraser, 1957) very little is known concerning its habits.

The adults are apparently far ranging, from as low as 600 feet at Cultus Lake, B. C. to over 5,000 feet at Mt. Rainier and Mt. Hood, but are nevertheless very rare and have a very restricted habitat preferance for spring fed bogs and swamps of high mountainous areas.

Distribution.—Specimens of the adults have been reported from British Columbia, Washington, Oregon, California, and Nevada. Tillyard (1917) apparently confused Nebraska with Nevada, for he gives Nebraska as a locality where this species occurs. There is little likelihood that *Tanypteryx hageni* occurs in this mid-western state.

Definitely identified nymphs of this species have thus far been reported only from Washington and Oregon (Svihla, 1958), although there is every reason to believe that they will be found eventually in California, British Columbia, and Nevada. Smith and Pritchard (1956) attributed specimens collected in Oregon to this species but they failed to describe them further.

Flight.—My observations confirm those of Mrs. Whitney (1947) that the adults of this species are strong fliers. At Still Creek Forest Camp, Mt. Hood, Oregon, I saw the adults flying about 25–30 feet above ground over the swale as well as back and forth down the road with excursions into embayments off the road into the woods in pursuit of prey. They followed a regular route along the roadway, sometimes dipping down to about 3 feet from the ground but most of the time flying much higher. They often settled on the ground (one was caught in this situation) as well as on the leaves of the red cedar and fir trees. The flight is usually strong and even but they live up to their name of "swift-winged" when, with short fast spurts, they are off in pursuit of prey or in the act of driving away interlopers who might have entered their territory. They do have a sense of territory and follow a definite route in their flights, for the same individual may be seen time after time returning to the same area, flying along the same path, or inspect-

ing the same embayments.

As Mrs. Whitney (1947) reports, this species apparently has an affinity for coming to rest on white objects. Byers (1930) has reported the same attraction in *Tachopteryx thoreyi* in Florida. *Uropetala carovei chiltoni* of New Zealand also shows a similar positive response, for specimens were picked by hand from a white towel upon which they had settled.

Pairing.—On July 6, 1957 a pair *in copula* was seen flying over the swale at Still Creek Forest Camp. They settled vertically on the leaves of a red cedar tree too high to observe any details of the clasping mechanism. They were netted for observation but after being caught the pair separated. Although they were released they went their individual ways and were not seen again.

Oviposition and Eggs.—At the present time because of the aeschnine-like ovipositors of the females, the Petaluridae are grouped with dragon flies which have endophytic oviposition. Tillyard (1909), discussing *Petalura gigantea* of Australia, stated that "the probability is that the eggs are actually inserted in decaying tissues". Williamson (1901) observed oviposition in *Tachopteryx thoreyi* but did not find the eggs. Wolfe (1953) described in detail oviposition in *Uropetala carovei chiltoni* of New Zealand and was the first to discover and locate the eggs. He found that the eggs were not inserted in plant tissues as had been postulated by Tillyard and hence were not endophytic but were deposited among moss, liverworts, and other bog plants below the water level. The eggs therefore were exophytic.

At Still Creek Forest Camp on July 8, 1958 a female *Tanypteryx hageni* was found in the moss south of the old swimming pool in the process of depositing eggs. She was on the ground, almost hidden by the vegetation, and had placed her arched abdomen about half way down into the moss. She moved about and assummed this position several times. Later the area into which she had placed her abdomen was examined and the eggs were found.

This female was captured and the tip of her abdomen placed in a small pan of water to encourage the deposition of eggs. She refused to comply. In this respect the female's negative action

was the same as that of the ovipositing female *Tachopteryx thoreyi* mentioned by Williamson (1901).

Walker and Ricker (1938) reporting on *Tanypteryx hageni* from Cultus Lake, B. C. stated that "a dragon fly thought to be of this species was observed ovipositing at intervals as she flew along midstream. Such a habit is not in accord with Kennedy's postulation, from observations of related species, that "*Tanypteryx hageni* would prove to be an inhabitant of bogs and swamps". At the time of Kennedy's report (1917) very little was known concerning *Tanypteryx hageni* but his postulations that this species would be found to be a dweller of mountainous bogs and swamps has in the main turned out to be correct.

Since the act of and site of oviposition in *Tanypteryx hageni* are similar to those described for *Tachopteryx thoreyi* and *Uropetala carovei chiltoni* the above mentioned observations of Walker and Ricker are open to question, particularly so since neither the female *Tachopteryx thoreyi* nor the female *Tanypteryx hageni* deposited eggs in open water when given the opportunity.

Eggs.—The eggs were found loose under the moss plants and, in this case at least, not attached to the leaves of the moss plants as Wolfe had reported for *Uropetala carovei chiltoni.* The eggs are ovoid in shape, typical of the eggs of exophytic dragon flies, and several hours after deposition light brown in color. They measured 1.05 mm. x .6 mm. in size. At the top of the egg is a small clear cap or pedicel (text-fig. 2). The shell surface is sculptured with many fine irregular corrugations or vermiculations.

The observations on oviposition in *Tanypteryx hageni* give credence to Wolfe's contention that probably all the Petaluridae do not have endophytic oviposition and that the Petaluridae probably represent a stage in the evolution of endophytic oviposition.

It is well known that the complete Odonate ovipositor is an ancient structure. It is probable that during Carboniferous times when bogs were very extensive the early dragon flies deposited their eggs in the decaying vegetation (even though they had well developed ovipositors) just as *Uropetala* and

Tanypteryx do now. This primitive bog habitat, together with the well developed ovipositor, is retained by the modern Petaluridae. In the further evolution of the Anisoptera, the Aeschnidae retained and increased the efficiency of the ovipositor for true endophytic oviposition, whereas in the Gomphidae and the Libellulidae a reduction took place and the eggs are now deposited directly into water. These differences in oviposition may have developed in association with changes from the original primitive bog habitat.

Hatching.—On July 24, 1958, or sixteen days after egg deposition, development of the pronymph could be seen well along within the eggs and on August 3, after a period of twenty-six days, one of the eggs hatched. Other eggs from this same batch did not hatch until August 8, a period of thirty-one days. Possibly the differences in temperature of the water in which the eggs were kept had something to do with the variation in hatching time.

Actual hatching was not observed, for the second instar nymph was already out of the egg. A pronymph occurs and its thin transparent sheath remains attached to the egg shell just as has been reported for *Petalura* and *Uropetala*. No spine is present at the tip of the abdomen of this species as has been reported by Tillyard for the pronymph of *Petalura*. In the absence of the spine, *Tanypteryx* is similar to *Uropetala*. Unfortunately, before drawings could be made the pronymph sheath was lost during the process of fixation for making permanent mounts.

Second Instar.—Tillyard calls the pronymph the first instar and this terminology is followed here. At the time of hatching, the second instar nymph is transparent. One of the striking features of the *T. hageni* nymph at this stage of development is the presence on the upper surface of the abdomen of very long upright hairs the tips of which are curved downward toward the body. As soon as this second instar nymph moves among the muck of its surroundings, it becomes indistinguishable because of the debris which is held by these hairs.

The eyes are small and widely separated. Antennae with three segments, third segment twice as long as first two and with many long setae. All setae on nymph long and slender. Labium: large; hinge of labial mask

extending down to middle of mesothoracic legs. Mentum: longer than wide; median lobe extending slightly forward and divided by a shallow cleft; minute denticulations on either side of cleft. Lateral lobes: truncate; inner and apical borders minutely denticulate; a short strong spine at base of long slender moveable spine. Segments of thorax and abdomen simple, the latter with many long setae on dorsal surface. Tarsi: single jointed with two curved claws. Tibia: with four strong spurs at distal end; an additional strong spine located medially on each tibia. Many long setae present on femur, tibia, and tarsus. Total length of second instar nymph 1.75 mm. (see text-fig. 4).

A description of the last instar nymph and exuvia of this species as well as a key to the known species of petalurids has been published in another paper, Svihla (1958). Since the date of the publication of this paper I have had the opportunity of examining an exuvium of *Tachopteryx thoreyi* kindly sent me by Dr. Minter J. Westfall, Jr., from Florida. Corroborating Byer's (1930) observation, this latter species also has a short spine at the base of the moveable spine, thus *Tanypteryx hageni* and *Tachopteryx thoreyi* are similar in this character.

The six known petalurid nymphs may be separated from each other by the following characters:

I. Lateral lobes of labium truncate, apical and inner borders denticulate
  A. Median lobe triangular, projecting forward ..... *Uropetala carovei*
  B. Median lobe not triangular, straight
    1. Hairy tubercles on abdomen
      a. 7 segmented antennae, 2 hair tufts on abdominal segments *Tachopteryx thoreyi*
      b. 6 segmented antennae, 4 hair tufts on abdominal segments *Phenes raptor*
    2. No hairy tubercles on abdomen
      a. Lateral spines on abdomen present, 2 hair tufts on abdominal segments ..... *Tanypteryx pryeri*
      b. Lateral spines on abdomen absent, 4 hair tufts on abdominal segments ..... *Tanypteryx hageni*

II. Lateral lobes of labium concave, inner borders curved, median lobe triangular ..... *Petalura gigantea*

Habitat of the nymph (see Plate I, figs. A, B).—On July 8, 1958 an exuvium of this species was found three inches above ground at the base of a sedge (*Carex ablata*) growing in a small open damp swampy area located on a hillside above Tipsoo Lake, Mt. Rainier National Park, Washington. Meandering

through this swampy area is a shallow spring-fed streamlet. Past experience with the habitat of the nymphs of *Uropetala carovei chiltoni* in New Zealand, which have their burrows along the sides of spring-fed streams, led me to expect that the nymph of *Tanypteryx hageni* would be found in a similar location. An extensive and diligent search for burrows similarly located was unsuccessful in the area where the exuvium was found. It was only when the stream bed itself was investigated that the burrows were revealed. I had also anticipated finding large conspicuous openings, well marked with an accumulated mass of debris similar to those of *Uropetala*, but, to the contrary, the openings of the burrows of *Tanypteryx hageni* are very small, being only from ⅜ to ½ inch in diameter, and inconspicuous because the mass of debris at the burrow opening is usually washed away.

Habitat of the nymphs at Still Creek Forest Camp, Mt. Hood, Oregon.—At Still Creek Forest Camp, Mt. Hood, Oregon, the nymphs were found in burrows as they were at Tipsoo Lake, Mt. Rainier National Park, Washington. Mrs. Whitney had examined this area (Swim) very thoroughly and diligently and summarized her search with the comment, "Where are the nymphs?" Several other Odonatologists had visited this area, and for four consecutive years I duplicated their unsuccessful searches. It was only after having discovered the nymphs at Tipsoo Lake that I was able to locate them at Still Creek Forest Camp. They were literally underfoot all the time but so specialized is the habitat that the burrows were very easily overlooked.

For the benefit of those who might be interested in this site, the burrows are to be found about 20 feet from the lower right-hand corner of the old concrete swimming pool at the edge of the cattail swale. A very slow flow of water trickles from an inconspicuous permanent spring located under the bank in the swale proper. Here, among mosses, *Carex* tussocks, and a flat expanse of *Marchantia polymorpha*, the nymphal burrows may be found. In some cases neat round openings are cut through the *Marchantia* thalli. It is futile to search for the nymphs in the rapid flowing stream in the center of the swale, for *Tanypteryx hageni* is not a stream dweller.

It was here also that a female was seen and captured while in the act of ovipositing. Many adults of both sexes are present here during the latter part of June and all of July, flying over the swale and up and down the road.

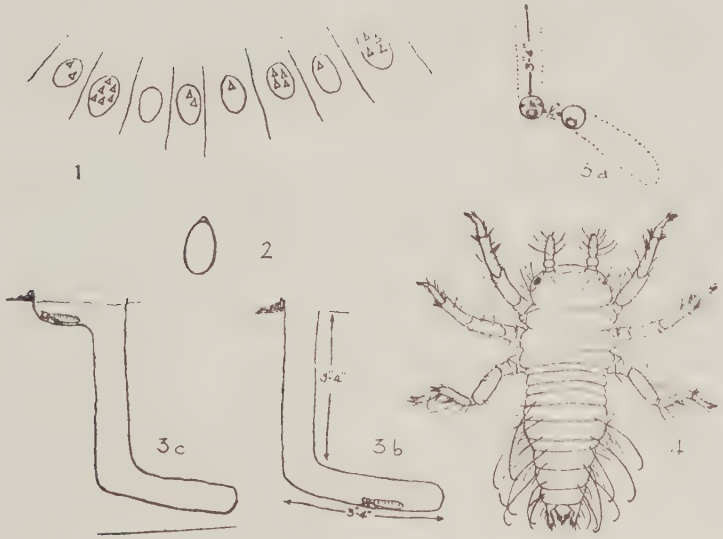
The habitat of the nymph of this dragon fly was found to be very restricted and specialized, for extensive search covering areas of several square miles in both localities in Oregon and Washington failed to reveal additional sites. It is therefore readily understood why, in the past, the nymphs of this species of *Tanypteryx* had eluded discovery.

In comparison with the burrows of *Petalura gigantea* of Australia and *Uropetala carovei chiltoni* of New Zealand, the burrows of *Tanypteryx hageni* are very simple, varying in diameter from ⅜ to ½ inch (last instar nymphs) and consist of two parts, an anterior vertical tube and a posterior horizontal section. The burrow opening usually leads directly to the vertical section which goes down for about 3 to 4 inches and then turns at right angles horizontally for another 3 to 4 inches (text-fig. 3b). In the stream bed this horizontal section is directed upstream. Sometimes the first portion of the tube is not strictly vertical but passes downward at an acute angle. Also occasionally, an additional short horizontal section which is a pool about the length of the nymph is found in front of the vertical section of the burrow (text-fig. 3c). Here the nymph may be found lying in wait for prey completely submerged and completely hidden in the accumulated debris.

The nymph is usually found at the burrow opening heading outward; if it is not there it will be found in the lower horizontal section.

Taketo (1958) has recently described the burrows of *T. pryeri*, the Japanese species. He found that in *T. pryeri* the burrows also occur in small boggy slopes and consist of a simple pit or blind tube of from 5 to 15 cm. in depth.

The habitat for the nymph of *T. hageni* seems to have two essential characters, (a) a permanent slow flow of water and (b) deep muck in which the burrows are constructed. The water supply must be permanent for apparently it requires several years for the larvae to develop and the flow must be slow because



Text-figures 1–4. Fig. 1, gizzard teeth of nymph of *Tanypteryx hageni;* fig. 2, egg; fig. 3a, burrow openings from above; fig. 3b, typical burrow from the side; fig. 3c, burrow with pool in same aspect; fig. 4, second instar nymph, dorsal aspect.

the nymphs do not swim and are relatively slow moving. The burrows were never found in gravel or clay soils.

In the Tipsoo Lake area of Mt. Rainier National Park, twenty-six burrows were found in the streamlet itself with two additional ones on the shore one foot away. In the Still Creek Forest Camp site fifteen burrows were counted. The burrows are irregularly distributed in the stream bed, sometimes under small waterfalls. Occasionally the openings of two burrows each occupied by a nymph, may be only ½ inch apart (text-fig. 3a).

Since the nymphal populations are small and the habitat very restricted and specialized it is very easy to understand why this species of dragon fly is rare. The temperature of the water in the burrows was taken on July 18, 1958 at Tipsoo Lake and was found to vary from 13° C. (55.8° F) to 20° C (68° F). During

the winter this area is covered with a snow layer ten or more feet thick. Snow commences to fall during November and remains until the latter part of June and the early part of July. On July 8, 1958 patches of snow were still present in the immediate vicinity of the burrows. At Still Creek Forest Camp similar conditions occur.

Tillyard (1911) stated the *Petalura gigantea* nymphs occur in "vile smelling mud". Although the nymphs of *T. hageni* do live in a mucky area, nevertheless the water which flows constantly into the burrows is always clear and unquestionably highly oxygenated. Wolfe (1953) has demonstrated that the water in the burrows of *Uropetala carovei chiltoni* is heavily charged with oxygen.

Daily activity of the nymphs.—Although nymphs may be seen at the mouths of the borrows at all times of the day or night, it is during the evening and at night that they seem to be most active and appear at the burrow opening in greatest numbers. Every burrow examined at night in the Tipsoo Lake region showed a nymph at the entrance facing outward awaiting prey. It was usually found at the lower part of the entrance but sometimes at the sides. The coloration of the nymph and its encrusted muck blends in so well with the debris at the entrance to the burrow that the nymph is very inconspicuous.

The nymphs are not very sensitive to light for the flash of light from a three-cell flashlight caused no retiring response, nor during the daytime did the shadow of a hand passing over the nymph bring about any movement.

Nymphs in captivity showed the same crepuscular and nocturnal activity as those in the wild, for during the daytime they remained quietly in the water at the bottom of a jar in which they were kept but as soon as it became dusk they climbed up the mesh of screen wire which had been placed in the jar and remained at the surface of the water or above during the evening and night.

Although the nymphs are largely crepuscular or nocturnal in habits and are usually found in the burrows, nevertheless, they sometimes forage away from the burrows, for a half-grown larva was seen out foraging away from its burrow at 1:00 P.M. on a

bright sunshiny day.

The nymphs usually clean their burrows at night, for fresh accumulations of debris may be seen deposited at the mouth openings. However, this cleaning activity may also be carried on during the daytime although less commonly.

Although the nymphs do not react very strongly to light, they are very sensitive to touch, especially to any movement of the material at the mouth of the burrow. A blade of grass placed in the debris at the burrow entrance and gently moved was immediately seized by the nymph. Sometimes so firmly did the nymph hold onto the grass blade that it was possible to pull the nymph out of its burrow. Usually, however, it let go before being pulled out too far. Small grasshoppers and spiders walking over the muck at the burrow entrance are immediately seized by them.

If, on the other hand, they are handled roughly when removed from the burrows during excavations, the nymph lies very quietly playing "possum" with its legs close to the body. This quietness plus their protective coloration undoubtedly has considerable survival value. The color of the nymph varies with the substratum, for it is light brown in a brown area, medium brown in a comparable site, and almost black when the burrow is of that color.

Air Breathing of Nymphs.—Tillyard (1917) has made some very interesting observations on air breathing in *Petalura gigantea*. In the case of *Tanypteryx hageni* the nymphs are usually found in the water of their burrows, yet they can remain out of water for hours, even for days or weeks during which time they become air breathers. On August 21, 1958 at Tipsoo Lake a nymph was seen in its burrow upside down with its head in water but with the abdomen above water. In this position and at this time it was air breathing because the anal plates were observed to open and close and a large air bubble expelled at intervals. This sequence of acts happened several times.

On another occasion a captive larva had crawled out of its container and was found several hours later 10 feet away covered with spider webs and fuzz but on being replaced in water showed no ill effects.

In the laboratory, specimens in jars containing moist muck have remained for weeks on the moist surface without burrowing. During all this time they were air breathing.

Laboratory specimens were fed meal worms which they seized with their strong, powerful, spined, lateral labial lobes.

Gizzard teeth.—The gizzard teeth of the Petaluridae have to date been described for only one species, *Petalura gigantea.* Tillyard (1917) stated that this species, using Higgins' (1901) designations, has a dental formula of f 8 (2–6). It is upon this datum that the Petaluridae are said to have 8 folds of gizzard teeth. Fraser (1957) also states that 8 folds are present in the Petaluridae but are armed with only one or two teeth, although his illustrations of *Petalura gigantea* show three teeth in one row.

In *Tanypteryx hageni* the gizzard teeth are also found in 8 rows with a dental formula of f 8 (0–6). The simple conical teeth are located on raised, oval-shaped chitinous areas (text-fig. 1).

The gizzard teeth in *Uropetala carovei chiltoni* are being described in another paper, but for comparative purposes it can be stated that although there are 8 folds in the gizzard of this species, the teeth are only found on 4 of them, the edentulous and dentulose folds alternating. There is but a single large tack-shaped tooth in this species.

It may be stated that as far as our present knowledge is concerned, 8 rows of gizzard teeth are characteristic of the Petaluridae and it is possible to identify the species by the number, shape, and distribution of their teeth.

Emergence dates.—At Tipsoo Lake, Mt. Rainier National Park, Washington, based on the collection of fresh exuviae, this species emerges from early July to July 30. None appeared after July.

Sex ratio.—Based upon determination of exuviae as well as adult nymphs, the sex ratio for this species is roughly even, for of the 7 exuviae collected 4 were ♂ and 3 were ♀, and of the nymphs collected 2 were ♂ and 4 were ♀.

Probable natural enemies of nymphs.—In the Tipsoo Lake region the following might be considered possible natural enemies of the nymphs. A small frog of the species *Rana cascadae,* was

seen snapping at and capturing a spider in the stream bed where the nymphs occur. Since the nymphs do forage away from the burrows they might be picked up by frogs of this species as well as by toads (*Bufo boreas*) which also occur in the same area. The long-toed salamander *Ambystoma macrodactylum* is also found in the immediate vicinity.

In the Still Creek Forest Camp area, *Rana pretiosa, Bufo boreas,* the salamander *Taricha granulosum,* and garter snakes occur in the immediate vicinity and are possible enemies of this species.

The nymphs, however, are well protected for they "play dead" when touched, and due to the debris collected in the hairs on the dorsal part of the abdomen they are almost invisible as their coloration blends in with the background.

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Explanation of Figures

Plate I

A (upper).—Photograph of burrow opening of *Tanypteryx hageni*. Opening to right of penny. Grass blade points to burrow opening.

B (lower).—Photograph of nymph of *Tanypteryx hageni* in borrow. Another burrow opening to right.

SVIHLA: LIFE HISTORY OF TANYPTERYX HAGENI SELYS

AN ANALYSIS OF THE TRIBES OF THE ROMALEINAE WITH SPECIAL REFERENCE TO THEIR INTERNAL GENITALIA (ORTHOPTERA; ACRIDIDAE)

BY

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In our study of the North American Romaleinae as a part of a monograph of the Orthoptera north of the United States-Mexican boundary [1] we have had to examine the subfamily as a whole. This was especially necessary in making tribal assignments of the North American genera. In order to make those assignments meaningful we have analyzed and placed in tribes the majority of the genera included in the subfamily.

As a basis for this work we have had available the rich collections of the Academy of Natural Sciences of Philadelphia which contain 36 of the approximately 46 genera at present included in the subfamily. Over 130 species were examined, 70 of them for genitalic characters.

Our procedure was to examine the genera for morphological characters found in the external anatomy using this as a preliminary basis for tribal classification. The results of the many dissections of male and female genitalia were then used as criteria for an independent classification to tribes. Finally, the two systems were compared and found to agree almost unerringly. In the few cases where external anatomy indicated one placement while genital morphology suggested another, we have relied upon the latter. The genitalia of representative genera and species are here figured. These were drawn from the dissected structures after maceration in a warm solution of 10% potassium hydroxide.

[1] We gratefully acknowledge support of this research by the National Science Foundation.

The endophalli and aedeagal valves were all drawn from the left side. Two views of each epiphallus were made—dorsal and anterior. In figures showing the epiphallus from the dorsum the structure's anterior edge is toward the top of the page. Every effort has been made to depict each epiphallus in the same position in order to facilitate comparison. Only the distal end of each female spermatheca is figured.

The morphological characters of this subfamily as well as their variation have been treated at some length by us in a paper now in press.[2] The phallic complex, and to a lesser extent the female spermatheca, exhibits a variational range which parallels that of the external morphology. Important systematic characters on the specific, generic, and tribal levels are to be found in the shape and relative size of the endophallic plates, form of the aedeagal valves (nearly always the dorsal pair), and in epiphallic structures.

The endophallus.—Only three components of this complex present sufficiently variable states of development to be taxonomically useful. These elements are the cingulum, endophallic plates, and aedeagal valves. Throughout the subfamily the "average" form of the cingulum is that of a membranous or very weakly sclerotized shield with short, broad apodemes connected by a thin, mid-longitudinal membrane and with reduced rami. Two principal variations occur. The apodemes may be reduced in width and at the same time elongate. This type of cingulum is found in the Romaleini and Zoniopodini. The second variant type is found in the Prionolophini and Colpolophini. In these tribes the cingulum is heavily sclerotized, darkly pigmented with short but well developed rami and, in the case of the former, with prominent dorso-lateral processes on the posterior border (fig. 53).

The structure of the endophallic plates varies conspicuously in their outline in lateral aspect. For example, the Zoniopodini and Chromacrini may be recognized at once by the ovate shape of the endophallic plates while the Procolpini and Brachystolini have narrow, elongate endophallic plates. Perhaps the most distinctive outlines are presented by the Chariacrini and Diponthini which have these plates retort shaped.

The dorsal aedeagal valves, however, are the most variable

[2] Proc. Acad. Nat. Sci. Phila., CXI (1959—in press).

structures of the endophallus, being absent in only two tribes—the Chromacrini and Batrachacrini. They are of low specialization in the Zoniopodini, Phrynotettigini, Coryacrini, Brachystolini, and Diponthini. In these tribes the dorsal aedeagal valves are usually small, simple, without processes, and with no or very poorly developed sculpturation. The median level of specialization is the mean for the subfamily. Within this category the dorsal aedeagal valves are larger, usually with a process or with prominent, often complex, sculpturation. The following tribes exhibit valves of this type: Dracotettigini, Colpolophini, Tropidacrini, Procolpini, Prionolophini, Elaeochlorini, Thrasyderini, and Romaleini (the last doubtfully because of the low magnitude of specialization). Only one tribe, the Chariacrini, may be said to have highly specialized dorsal valves—these being elongate and set with hooks.

The ventral aedeagal valves are almost never sclerotized or otherwise developed and usually appear as fleshy, finger-like protuberances of variable size. They are somewhat sclerotized in the Brachystolini and Chromacrini, but are truly specialized in only one tribe—the Diponthini. In this tribe the ventral valves are exteriorly sclerotized, produced dorsad and laterad of the dorsal valves, and may be apically spoon-shaped.

The epiphallus.—This structure is widely variable and of prime importance on nearly all systematic levels in the present subfamily. So variable is it that no mean or average can be given as typical for the group. In relation to the endophallus, the size of the epiphallus varies between two extremes. In the Diponthini and Prionolophini it is very small—almost minute in the former. In the Zoniopodini and Tropidacrini it is massive, especially in the latter. The bulk of the tribes possess epiphalli about midway between these two extremes.

The bridge of the epiphallus may be thick or thin, with or without toothing or a median protuberance, and either straight or medially depressed in anterior aspect. The condition of the bridge does not seem to be correlated with the development of other epiphallic structures.

The ancorae are always present, usually of medium size, but very large in a few tribes (Tropidacrini, Prionolophini, and Col-

polophini) while being small to obsolete in some species of the Chromacrini.

The most variable of the epiphallic structures are the lophi. These are always well developed and frequently very large. The lophi of nine tribes possess an apical process in the form of a boss, tooth-like or mammillate projection and one of these (Thrasyderini) has an additional, subapical process. Four tribes (Zoniopodini, Tropidacrini, Chariacrini, and Diponthini) lack a lophal process, while in three tribes it is present in some of the forms and absent in others (Phrynotettigini, Romaleini, and Brachystolini). In some genera of the Tropidacrini, the lophi bear a blunt, low, subapical ridge on the anterior face. In size the lophi range from small (Diponthini) to massive (Tropidacrini) but are usually of moderate size.

The female spermatheca.—The importance of this structure in the systematics of the Acrididae was first pointed out by Slifer[3] and more recently by Dirsh.[4] Its range of variation in the Romaleinae is considerably less than that found in other subfamilies of the Acrididae. In the Romaleinae its usual development (fig. 46) consists of a relatively simple tube of variable length, the apex of which is thickened and recurved and which possesses an incipient apical diverticulum (terminology of Slifer). Two tribes (Batrachacrini and Diponthini) and a single species of the Colpolophini (*C. obsoleta*) have the apical diverticulum well developed and clearly recognizable. In one tribe (Zoniopodini) the apical diverticulum is totally lacking and in another (Phrynotettigini) it is either present or absent (absent in *Tytthotyle* and *Phrynotettix tshivavensis*). In every genus and species studied the preapical diverticulum is recurved (although very weakly so in the Batrachacrini) usually involving the apex, but occasionally before the apex (Thrasyderini, Tropidacrini, Procolpini, Dracotettigini, and Elaeochlorini—except in the genus *Elaeochlora*). This recurvature of the preapical diverticulum is a characteristic of the subfamily.

In our analysis of the Romaleinae we have recognized sixteen

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[3] Journ. Morph., 65, pp. 437–469 (1939); ibid., 66, pp. 175–195 (1940); ibid., 67, pp. 199–239 (1940).

[4] Proc. R. Ent. Soc. London (A), 32, pp. 107–114 (1957).

tribes based only on the genera available to us. Studies of those not seen by us may require description of new tribes or may add to the components of those described here. We feel, however, that the basic tribal system here erected will require only minimal alterations.

All figures of the genitalia were made in pencil by one of us (Grant) and inked by our staff artist, Mr. Vernon Hüppi, whose excellent work we are pleased to acknowledge. We also wish to thank Mrs. Arthur Hurwitz for her careful and patient work in mounting and labelling the 21 plates.

In order to make the following figures of greatest use to taxonomists we are listing the locality data pertaining to each figured specimen.

Agriacris basalis, figs. 81–83, Provincia Sara, Bolivia
Agriacris basalis, fig. 92, Provincia Sara, Bolivia
Agriacris bivittata, figs. 87–88, Villavicencio, Colombia
Agriacris jacunda, figs. 84–86, Brasso, Trinidad
Agriacris tricristata, figs. 89–90, Gatun, Canal Zone, Panama
Alcamenes cristatus, figs. 47–49, Sapucay, Paraguay
Alcamenes cristatus, fig. 45, Sapucay, Paraguay
Batrachacris viridis, fig. 145, Concepcion, Chile
Batrachacris viridis, figs. 146–148, Concepcion, Chile
Brachystola magna, figs. 94–96, Canadian, Texas
Brachystola magna, fig. 97, Tucson, Arizona
Chariacris miniacea, figs. 136–138, Provincia Sara, Bolivia
Chromacris icterus, figs. 116–117, Villavicencio, Colombia
Chromacris miles, figs. 118–119, Alto Pencosa, Argentina
Chromacris miles, fig. 120, Chacras de Coria, Argentina
Chromacris psittacus, fig. 115, Barro Colorado Island, Canal Zone, Panama
Chromacris stolli, figs. 113–114, Bartica, British Guiana
Chromacris trogon, figs. 110–112, S. of La Emilia, Costa Rica
Cibotopteryx variegata, figs. 78–80, "Central America"
Cibotopteryx variegata, fig. 93, "Central America"
Colpolopha bruneri, figs. 30–32, Monte Redondo, Costa Rica
Colpolopha bruneri, fig. 40, El Hiquito, Costa Rica
Colpolopha obsoleta, figs. 27–29, Flores, Amazonas, Brazil
Colpolopha obsoleta, fig. 39, Sabana Mendoza, Los Andes, Venezuela
Colpolopha praemorsa, figs. 33, 35, Yurimaguas, Peru
Coryacris angustipennis, figs. 61, 63–65, Santa Cruz de la Sierra, Bolivia
Coryacris angustipennis, fig. 62, Santa Cruz de la Sierra, Bolivia
Diponthus crassus, figs. 143–144, Puerto Cantera, Paraguay

Diponthus paraguayensis, figs. 139–141, Sapucay, Paraguay
Diponthus paraguayensis, fig. 142, Sapucay, Paraguay
Draconata mancus, figs. 36–38, La Palmeta, Colombia
Draconata mancus, fig. 41, La Palmeta, Colombia
Dracotettix plutonius, fig. 11, Wild Rose Canyon, California
Dracotettix plutonius, figs. 12–14, Wild Rose Canyon, California
Elaeochlora brachyptera, figs. 75–77, Santa Cruz de la Sierra, Bolivia
Elaeochlora viridicata, figs. 72–74, Misiones, Argentina
Elaeochlora viridicata, fig. 91, Misiones, Argentina
Eutropidacris cristata, fig. 129, Bartica, British Guiana
Lophacris olfersi, figs. 130–131, Yurimaguas, Peru
Munatia decorata, figs. 8–10, Carillo, Costa Rica
Phrynotettix sp., figs. 19–20, 15 ms. W. of Monterrey, Nuevo Leon, Mexico
Phrynotettix sp., fig. 21, Higueros, Coahuila, Mexico
Phrynotettix robustus ssp., figs. 22–23, Chinati Mountains, Texas
Phrynotettix tshivavensis magnus, figs. 15–17, 2 ms. N. of Oro Blanco, Arizona
Phrynotettix tshivavensis magnus, fig. 18, 2 ms. N. of Oro Blanco, Arizona
Prionolopha serrata, figs. 42–44, Sapucay, Paraguay
Prionolopha serrata, fig. 46, Sapucay, Paraguay
Procolpia inclarata, figs. 4–6, Fortin, Vera Cruz, Mexico
Procolpia minor, figs. 1–3, Sapucay, Paraguay
Procolpia minor, fig. 7, Provincia Sara, Bolivia
Romalea microptera, figs. 69–70, Miami, Florida
Taeniopoda eques, figs. 66–68, Naco, Arizona
Taeniopoda eques, fig. 71, Naco, Arizona
Thrasyderes leprosus, figs. 132, 134–135, Durán, Ecuador
Thrasyderes leprosus, fig. 133, Durán, Ecuador
Titanacris albipes, figs. 127–128, Teffe, Amazonas, Brazil
Tropidacris dux, figs. 124–125, Eden, Nicaragua
Tropidacris latreillei, figs. 121–123, Quiriquire, Venezuela
Tropidacris latreillei, fig. 126, Manaos, Amazonas, Brazil
Tytthotyle maculata, figs. 24–25, Needles, California
Tytthotyle maculata, fig. 26, Bagdad, California
Xyleus angulatus, figs. 50–53, Independencia, Parahyha, Brazil
Xyleus angulatus, fig. 59, Independencia, Parahyha, Brazil
Xyleus centralis, fig. 56, Almoloya, Oaxaca, Mexico
Xyleus laevipes, fig. 57, Sapucay, Paraguay
Xyleus mexicanus, fig. 54, Merida, Yucatan
Xyleus regularis, fig. 55, Sapucay, Paraguay
Xyleus rosulentus, fig. 58, Cincinnati, Santa Marta, Colombia
Xyleus strigatus, fig. 60, Provincia Sara, Bolivia
Zoniopoda cruentata, figs. 103–104, Misiones, Argentina

Zoniopoda cruentata, fig. 105, Chacras de Coria, Argentina
Zoniopoda exilipes, figs. 98–100, Sapucay, Paraguay
Zoniopoda iheringi, figs. 101–102, Sapucay, Paraguay
Zoniopoda omnicola, figs. 106–107, Sapucay, Paraguay
Zoniopoda similis, figs. 108–109, Sapucay, Paraguay

The following abbreviations have been used in the plates: A = ancora; AD = apical diverticulum; AP = aedeagal process of endophallic plates; DAV = dorsal aedeagal valves; EP = endophallic plate; ES = ejaculatory sac; GP = gonopore process; L = lophus; PD = preapical diverticulum; VAV = ventral aedeagal valves.

Procolpini new tribe

Components.—Procolpia Stål, *Munatia* Stål, *Aeolacris* Scudder, *Prorhachis* Scudder, and *Xomacris* Rehn.

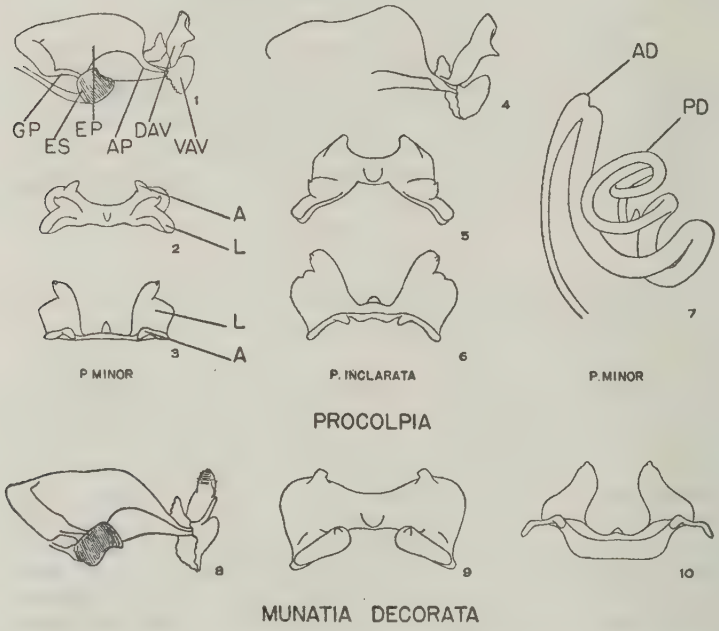
External characters of the tribe.—Form subcompressed; surface of head, thorax and limbs with numerous small subspiculate points (except on head of *Aeolacris,* which lacks them). Rostrum markedly developed, acutely produced as seen from dorsum; interantennal median section of rostrum in greater part lamellately compressed (least marked in *Aeolacris*), with frontal costa usually not indicated dorsad of the median ocellus. Facial line in profile concave, usually markedly so. Antennae ensiform. Pronotum with median carina cristate or in part subcristate, or at least well indicated throughout (except in *Aeolacris*); caudal angle of pronotal dorsum acute produced. Alar organs fully developed; tegmina in outline sublanceolate or truncate distad (if latter generally abruptly so); wings with specialized transverse veinlets of first vannal area present, but not always numerous nor strongly developed; weak or marked alar fenestrate areas present (marked in *Procolpia* and *Aeolacris*). Prosternal process spiniform, erect. Interspace between mesosternal lobes subequal to or narrower than that between metasternal lobes. No Krauss' organ present. Caudal tibiae with internal marginal spines in length always greatly exceeding the external ones, former incurved toward tibial axis. No median furcula present in male. Subgenital plate of male acute produced, not divided at apex.

Phallic characters of the tribe.—Endophallic plates dorso-ventrally narrow, small; aedeagal process weakly flexed, slender; gonopore process slender. Dorsal aedeagal valves large; with a weak (*Munatia*) to pronounced (*Procolpia*) subapical, latero-posteriorly directed process. Ventral aedeagal valves fleshy, poorly developed. Cingulum membranous.

Epiphallus with a prominent median protuberance on dorsal face of bridge. Lophi large, each with a prominent apical tooth-like or mammillate process. Lateral plates large. Ancorae small. (See figs. 1–10.)

Female spermatheca.—The female spermatheca of *Procolpia minor* (the only genus and species examined for this structure) possesses an incipient

apical diverticulum and an elongate preapical diverticulum. The preapical diverticulum is coiled and reduced in diameter apically. It is preapically recurved (see fig. 7).[5]



Figs. 1–10. Genitalia of the tribe Procolpini. Figs. 1, 4, 8—endophalli; figs. 2, 5, 9—epiphalli (dorsal aspect); figs. 3, 6, 10—epiphalli (anterior aspect); fig. 7—female spermatheca.

Material examined.—The following genera and species have been examined by us: *Procolpia*—**P. minor* Giglio-Tos,[6] **P. inclarata* (Walker), *P. emarginata* (Serv.), *P. centurio* Rehn, *P. lankesteri* Rehn; *Munatia*—**M. decorata* Carl, *M. biolleyi* Carl; *Aeolacris*—*A. bella* Rehn, *A. caternaulti* (Fiesth.), *A. octomaculata* (Scudder); *Prorhachis*—*P. granulosa* Scudder; *Xomacris*—*X. nuptialis* (Gerst.).

Variation in the phallic complex.—In basic structure, the phal-

[5] An additional species, *Procolpia emarginata,* is figured by Slifer, Journ. Morph., 67, pl. 2, fig. 12 (1940). The structure in this species agrees with *P. minor.*

[6] Species indicated with an asterisk in this and following "material examined" sections have been examined for genitalic characters.

lic complex of the two genera studied is similar. *Procolpia* differs from *Munatia* chiefly in the form of the dorsal aedeagal valves and in details of the epiphallus. In *Procolpia* these valves are unsculptured and possess a prominent subapical process (figs. 1, 4). In *Munatia* the process is much reduced and the anterior face of the distal quarter of each valve bears transverse sculpturations (fig. 8). The epiphalli vary as indicated in figs. 2, 3, 5, 6, 9, 10.

Between the species of *Procolpia* studied, *P. minor* differs from *P. inclarata* in the dorsal outline of the endophallic plates, form of the dorsal aedeagal valve process, and epiphallic details (see figs. 1–6).

Dracotettigini new tribe

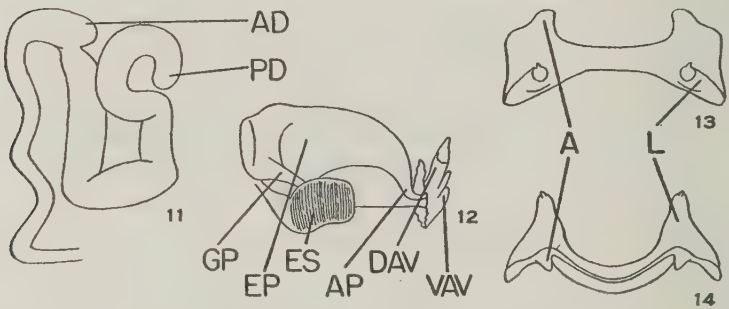
Components.—*Litoscirtus* Bruner and *Dracotettix* Bruner.

External characters of the tribe.—Brevialate to fully alate. Head with rostrum little produced (*Litoscirtus*) to distinctly produced as seen in profile (*Dracotettix*); fastigium with its lateral margins at most but weakly cingulate, scutellum of fastigium shallowly to definitely excavate; occiput with a distinct medio-longitudinal carina; lateral (accessory) facial carinae present but weak, sinuate. Antennae with 15–20 articles. Pronotum with median carina low cristate (*Litoscirtus*) to lopho-cristate (in certain *Dracotettix*), intersected by all the principal transverse sulci; lateral carinae of pronotal dorsum marked throughout, cut by all principal transverse sulci; prozona at least as long as metazona; caudal margin of pronotal dorsum acute-angulate produced. Tegmina well divided transversely into two sections by the first anal vein. Wings with sigmoid transverse veinlets of the vannal area evident but not strongly developed, with surface of some bearing minute nodulosities. Krauss' organ well developed, multistriate. Prosternal process erect, broad cuneate, blunt, cephalic face deplanate to varying degrees. Terminal abdominal tergite of male without distinct median furcula. Subgenital plate of male entire at apex. Internal series of caudal tibial spines appreciably longer than those of the external series, distinctly incurving toward the axis of the tibia.

Phallic characters of the tribe.—Endophallic plates small, elongate, quite narrow dorso-ventrally; aedeagal process slender, strongly flexed; gonopore process heavy. Dorsal aedeagal valves small, distally subacute, lacking sculpturation; each with a lateral, subapical, lamellate, latero-ventrally directed process. Ventral aedeagal valves small, fleshy lobes. Cingulum membranous.

Epiphallus large in relation to endophallus. Lophi large, apically narrowed, each with a small, apical, mammillate process. Lateral plates well developed. Ancorae of medium size. (See figs. 12–14.)

Female spermatheca.—The female spermathecae of both *D. plutonius* and *D. monstrosus* were studied. One of the species (*D. plutonius*) possesses an incipient apical diverticulum, while this structure is barely evident in the other. The preapical diverticulum is somewhat elongate, thickened, and preapically recurved (fig. 11).



DRACOTETTIX PLUTONIUS

Figs. 11–14. Genitalia of the tribe Dracotettigini. Fig. 11—female spermatheca; fig. 12—endophallus; figs. 13, 14—epiphallus (dorsal and anterior aspects).

Material examined.—The following genera and species have been studied by us: *Litoscirtus—L. insularis* Bruner; *Dracotettix—D. newboldi* Hebard, **D. plutonius* Bruner, **D. monstrosus* Bruner.

Variation in the phallic complex.—Only two species of *Dracotettix* were studied and these show very little variation. These species may best be separated on external characters, the only differences noted in the genitalia being extremely subtle ones in the dorsal aedeagal valves and epiphallus.

Phrynotettigini

1943. Phrynotettigini Uvarov, Trans. R. Entom. Soc. London, 93, pp. 20 and 29.

Components.—Phrynotettix Glover and *Tytthotyle* Scudder.

External characters of the tribe.—Build stocky and batrachiform (*Phrynotettix*) to relatively slender (*Tytthotyle*). Brachyalate to fully alate. Head without rostrate production; fastigium with its lateral margins cingulate, with or without similar cephalic definition, scutellum of fastigium hardly at all to distinctly excavate; lateral (accessory) facial carinae markedly

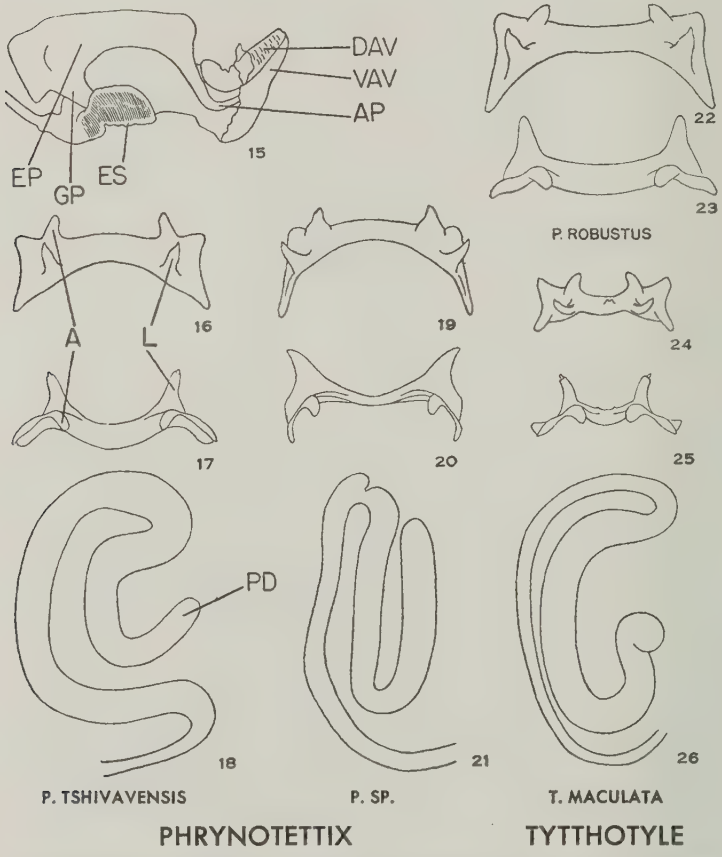
sinuate, not strongly developed, ventrad sometimes obsolete. Antennae with 19 to 24 articles. Pronotum with dorsal surface subdeplanate, elongate peltate, diamond-shaped with its caudal margin produced over the abdomen in an acute metazonal extension (*Phrynotettix*) or of more normal acridoid type with the caudal margin acute-angulately produced (*Tytthotyle*), surface of pronotum erosely cicatricose or heavily granulose (*Phrynotettix*) or smooth with scattered very low rounded nodes (*Tytthotyle*); median pronotal carina evident only on the metazona or obsolete; lateral carinae of pronotal dorsum obsolete (*Tytthotyle*) or marked cicatriform shoulders (*Phrynotettix*); transverse sulci intersecting all carinae, all equally marked or the principal one more strongly than those more cephalad, which may be less strongly indicated; metazona always longer than the prozona. Tegmina of the brachypterous subcircular type not surpassing the caudal apex of the pronotum (in certain forms of *Phrynotettix*), brevialate and subequal to the pronotal length (in the male sex of one species of *Phrynotettix*) or elongate, surpassing the apices of the abdomen and of the caudal femora (*Tytthotyle*), not at all or little differentiated in surface character transversely (*Phrynotettix*) or with a well marked transverse surface differentiation by the first anal vein. Wings developed in proportion to the tegmina, all *Phrynotettix*, except males of *P. robustus*, with them greatly reduced; sigmoid transverse veinlets of the first vannal area present, but of limited extent in the short winged *Phrynotettix*, surface nodulosities few on these veinlets in the reduced winged form of *Phrynotettix*. Krauss' organ well developed and multistriate in *Phrynotettix*, no striae present in *Tytthotyle*. Prosternal process at most a very low tubercle, virtually absent in females of *Tytthotyle*. Terminal abdominal tergite of male lacking median furcula, but margins more laterad with very low lobulations. Subgenital plate of male entire at apex. Internal series of caudal tibial spines somewhat longer than those of the external series, distinctly incurved toward the axis of the tibia.

Phallic characters of the tribe.—Endophallic plates dorso-ventrally broad in relation to length, at most weakly arcuate in dorsal outline; aedeagal process robust, strongly flexed; gonopore process slender (*Tytthotyle*) or heavy (*Phrynotettix*). Dorsal aedeagal valves robust, with fine sculpturation (*Phrynotettix*) or smooth (*Tytthotyle*); bases strongly developed and sometimes ornamented (*Tytthotyle*). Ventral aedeagal valves well developed, but exteriorly fleshy. Cingulum chiefly membranous; rami weakly sclerotized.

Epiphallus with simple bridge, or with small, poorly developed dentition (*Tytthotyle*). Lophi small, variable, usually with a distal tooth or mammillate process. Lateral plates little to well developed. Ancorae well developed. (See figs. 15–26.)

Female spermatheca.—The female spermatheca is variable in the present tribe. An incipient apical diverticulum is absent in *Tytthotyle* and in

Phrynotettix tshivavensis, but is present in *P. robustus* and *P.* sp.[7] The preapical diverticulum is thickened, short and apically recurved (figs. 18, 21, 26).



Figs. 15–26. Genitalia of the tribe Phrynotettigini. Fig. 15—endophallus; figs. 16, 19, 22, 24—epiphalli (dorsal aspect); figs. 17, 20, 23, 25—epiphalli (anterior aspect); figs. 18, 21, 26—female spermathecae.

[7] This species is described in a paper by the present authors now in press. See Rehn and Grant, "A Review of the Romaleinae (Orthoptera; Acrididae) found in America North of Mexico," Proc. Acad. Nat. Sci. Phila., CXI (1959—in press).

Material examined.—We have been able to examine all the species of the two genera included in this tribe. *Phrynotettix*—**P. tshivavensis*, **P. robustus*, **P.* sp.; *Tytthotyle*—**T. maculata*.

Variation in the phallic complex.—The internal male genitalia of this tribe present considerable variation. *Tytthotyle* differs widely from *Phrynotettix* in the character of its endophallus, especially the dorsal aedeagal valves, and in details of the epiphallus. Of especial note is the peculiar tooth-like apical process of the lophi in *Tytthotyle* which is quite unlike that found in any other species examined by us (fig. 25). This tooth-like process is set in a shallow concavity. Among the species of *Phrynotettix*, both details of the epiphalli and of the dorsal aedeagal valves are of positive value in determining the species (figs. 15–17, 19, 20, 22, 23).

Colpolophini new tribe

Components.—*Colpolopha* Stål, *Draconata* Pictet and Saussure, and *Helionotus* Rehn.

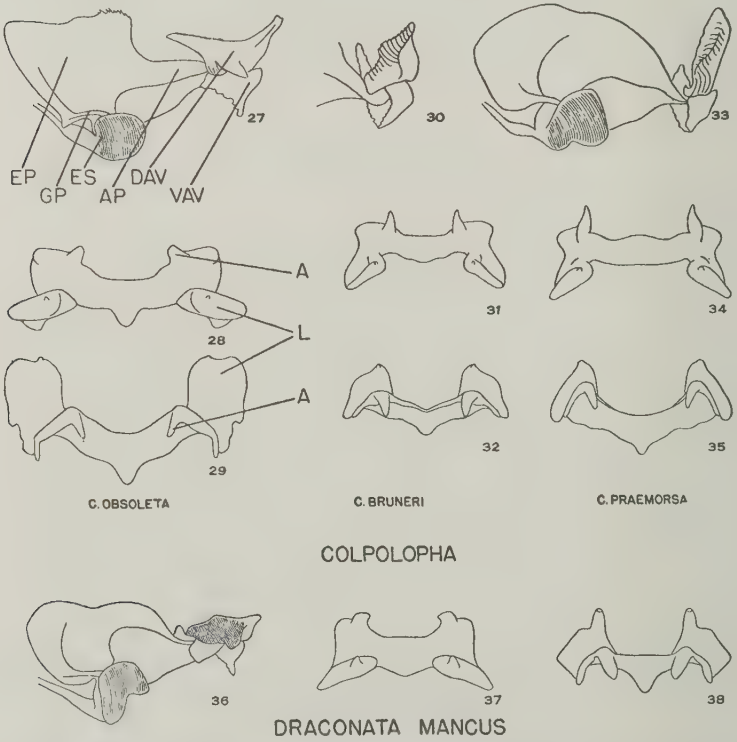
External characters of the tribe.—Form compressed (less so in *Helionotus*); surface of head, thorax and limbs often rugulose, or even with scattered raised points. Rostrum moderately to distinctly (*Colpolopha*) produced, but not sharply cut off from facial outline as seen in profile; interantennal section of rostrum compressed but with frontal costa distinctly evident dorsad to the fastigio-facial angle. Facial line in profile nearly straight oblique; faintly concave at most. Antennae at most no more than subensiform in outline (in *Colpolopha*). Pronotum with median carina cristate throughout (*Colpolopha*), the prozona with three dentate lobations and the metazonal section cristate (*Helionotus*) or strongly carinate (*Draconata*); caudal angle of pronotal dorsum acute produced. Alar organs fully developed (species of *Colpolopha*) to greatly reduced in size and either subovate in outline (*Draconata*) or with their terminal costal marginal lobation greatly expanded (*Helionotus*[8]); wings with specialized transverse veinlets of the first vannal area present, but varying in number and extent; marked alar fenestrate areas present (in *Colpolopha*). Prosternal process conical, erect. Interval between mesosternal lobes subequal to or narrower than that between the metasternal lobes. No Krauss' organ present. Caudal tibiae with internal marginal spines much longer than external ones, former incurved toward tibial axis. No true median

[8] This type of development is also strongly marked in certain species of *Colpolopha*, as *simplex* Hebard, *bruneri* Rehn, *sinuata* Stål, *metae* Hebard, and *latipennis* Stål.

furcula present in males. Subgenital plate of male short acute, not divided at apex.

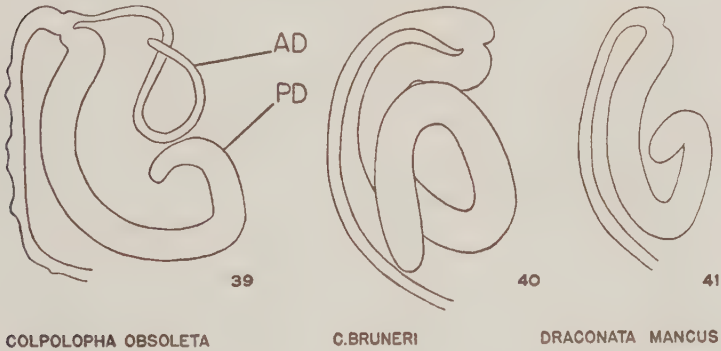
Phallic characters of the tribe.—Endophallic plates dorso-ventrally broad, of medium size; aedeagal process weakly flexed, usually heavy; gonopore process slender. Dorsal aedeagal valves very large, robust to massive; with or without a lateral process; with fine to coarse transverse sculpturations. Ventral aedeagal valves membranous, poorly developed. Cingulum sclerotized and darkly pigmented, but dorso-medially the sclerotic elements are connected by membrane only; rami stout; apodemes short and broad.

Epiphallus with a prominent median protuberance on ventral face of bridge. Lophi large, each with a distinct apical mammillate process. Lateral plates large. Ancorae large. (See figs. 27–41.)



Figs. 27–38. Genitalia of the tribe Colpolophini. Figs. 27, 33, 36—endophalli; fig. 30—aedeagal valves; figs. 28, 31, 34, 37—epiphalli (dorsal aspect); figs. 29, 32, 35, 38—epiphalli (anterior aspect).

Female spermatheca.—Although only three species were dissected (*Colpolopha obsoleta, C. bruneri* and *Draconata mancus*) in order to study this character, a surprising variation was observed. Both *Colpolopha* and *Draconata* possess a thickened, recurved, preapical diverticulum. In *Draconata mancus* and *Colpolopha bruneri* there is an incipient apical diverticulum. *Colpolopha obsoleta,* however, possesses a well developed, slender and apically recurved apical diverticulum. (See figs. 39–41.)



Figs. 39–41. Female genitalia (spermathecae) of the tribe Colpolophini.

Material examined.—We have studied the following genera and species: *Colpolopha—C. simplex* Hebard, **C. bruneri* Rehn, *C. rehni* Hebard, *C. sinuata* Stål, *C. metae* Hebard, *C. biloba* Pict. and Sauss., *C. latipennis* Stål, **C. praemorsa* (Gerst.), **C. obsoleta* (Serv.); *Draconata—***D. mancus* Pict. and Sauss.; *Helionotus—H. mirabilis* Rehn.

Variation in the phallic complex.—The basic structure of the phallic complex found in this tribe is similar for the species examined, but in detail it varies rather widely. Two types of dorsal aedeagal valves are present. Type one is very large, elongate antero-posteriorly and possesses lateral processes. This type is found in *Colpolopha obsoleta* and *Draconata mancus* (figs. 27, 36). Type two is smaller, elongate dorso-ventrally and lacks lateral processes. It occurs in *Colpolopha praemorsa* and *C. bruneri* (figs. 30, 33). On the basis of internal genitalia, *Colpolopha obsoleta* and *Draconata mancus* cannot be generically differentiated although they are well separated by specific details of the endophallus and epiphallus (figs. 27–29, 36–38). Further

taxonomic study of the components of these genera is indicated. *Colpolopha praemorsa* differs from *C. bruneri* in details of the dorsal aedeagal valves, aedeagal process and epiphallic characters as indicated in figs. 30–35.

Prionolophini new tribe

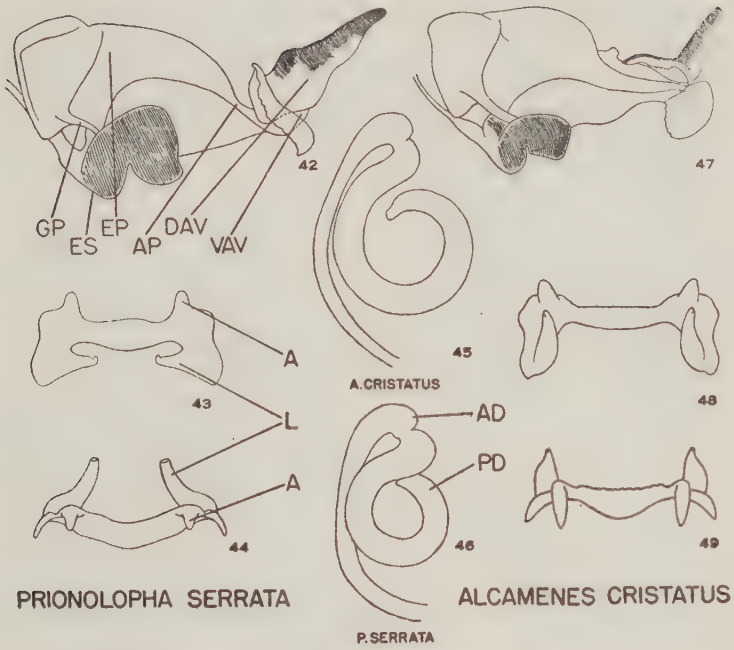
Components.—*Prionolopha* Stål, *Alcamenes* Stål, and *Xyleus* Gistel.

External characters of the tribe.—Form compressed, surface of head, thorax and limbs with nothing heavier than granulations. Rostrum with the fastigium acute to rectangulate as seen from dorsum, not cut off in form or character from the general form of the head, its ventral outline, as seen in profile, passing without break into that of the face; frontal costa reaching to the fastigio-facial angle, sulcate or non-sulcate. Antennae faintly ensiform only in *Prionolopha*. Pronotum with its median carina outlining a regularly arcuate or subarcuate crest, with its highest point on the metazona; caudal angle of pronotal dorsum elongate acute produced. Alar organs fully developed to brevialate (*Alcamenes*); tegmina in outline ranging from acuminate (*Alcamenes*) to elongate lanceolate; wings with specialized transverse veinlets of the first vannal area numerous; alar fenestrate area well developed. Prosternal process thick longitudinally, compressed, distinctly retrorse, apex blunt acute. Interspace between mesosternal lobes subequal to or narrower than that between the metasternal lobes. No Krauss' organ present. Caudal tibiae with internal marginal spines somewhat, but not greatly, longer than the external ones, somewhat inbowed toward the tibial axis. No median furcula present in male. Subgenital plate of male acute produced, not divided at apex.

Phallic characters of the tribe.—Endophallic plates of medium size and average form for the subfamily; aedeagal process but moderately flexed, semi-robust; gonopore process moderately heavy. Dorsal aedeagal valves large and heavy; with coarse to microscopic sculpturation. Ventral aedeagal valves poorly developed, appearing as fleshy lobes. Cingulum well developed, moderately to heavily sclerotized; zygoma imperfect, dorso-medially membranous; with prominent dorso-lateral processes on the posterior border (fig. 53).

Epiphallus with bridge medially thickened. Lophi moderately large, each with a blunt, sclerotic apical boss. Lateral plates comparatively well developed. Ancorae proportionately large. (See figs. 42–60.)

Female spermatheca.—This structure is quite similar in the three genera included in the tribe. The female spermatheca possesses an incipient apical diverticulum and a thickened, recurved preapical diverticulum. Little variation occurs among the various species of the included genera. (See figs. 45, 46, 59).

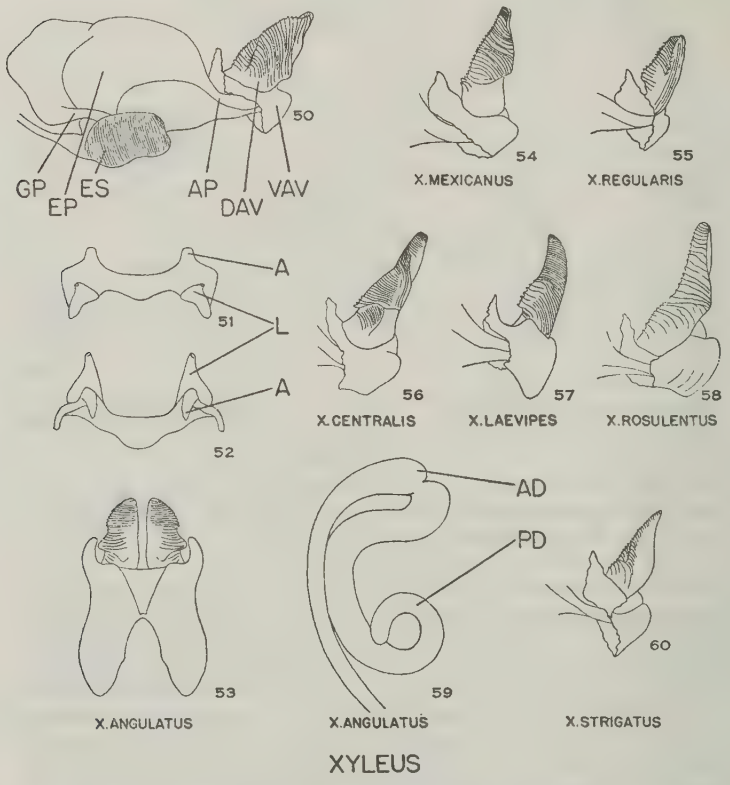


Figs. 42–49. Genitalia of the tribe Prionolophini. Figs. 42, 47—endophalli; figs. 43, 48—epiphalli (dorsal aspect); figs. 44, 49—epiphalli (anterior aspect); figs. 45, 46—female spermathecae.

Material examined.—We have studied the following genera and species: *Prionolopha*—**P. serrata* (L.); *Alcamenes*—**A. cristatus* Bruner, *A. lobipennis* Bruner; *Xyleus*—**X. rosulentus* (Stål), **X. discoideus* (Serv.), **X. angulatus* (Stål), **X. strigatus* (Bruner), **X. centralis* (Rehn), **X. mexicanus* (Bruner), *X. affinis* (Bruner), **X. regularis* (Bruner), *X. guarani* (Rehn), **X. laevipes* (Stål), *X. gracilis* (Bruner), *X. attenuatus* (Rehn), *X. lineatus* (Bruner).

Variation in the phallic complex.—In phallic characters this tribe is remarkably homogenous. *Prionolopha* may be readily distinguished by its massive dorsal acdeagal valves, rather less elongate ancorae and attenuate lophi (figs. 42–44). *Alcamenes,*

on the basis of its phallic structures is closer to *Prionolopha* than to *Xyleus*. In this latter genus, the epiphalli are all very similar, in some cases being specifically indistinguishable. The dorsal aedeagal valves of the various species of *Xyleus* provide excellent specific characters (figs. 50, 54–58, 60).



Figs. 50–60. Genitalia of the tribe Prionolophini. Fig. 50—endophallus; figs. 51, 52—epiphallus (dorsal and anterior aspects); fig. 53—dorsal aedeagal valves and cingulum (dorsal aspect); figs. 54, 55, 56, 57, 58, 60—aedeagal valves; fig. 59—female spermatheca.

Coryacrini new tribe

Component.—Coryacris Rehn.

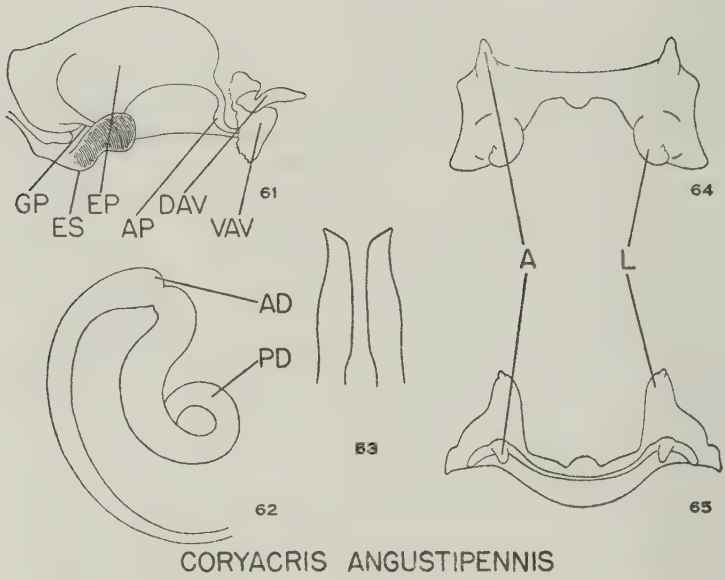
External characters of the tribe.—Form weakly compressed; surface of pronotum and pleura impresso-punctate. Rostrum moderately produced as seen in both dorsal and lateral aspects, fastigium trigonal as seen from dorsum; facial line little concave; frontal costa carried dorsad to fastigio-facial angle, sulcate throughout. Antennae terete. Pronotum weakly tectate dorso-cephalad, the median carina distinct over the whole discal length; caudal angle of pronotal dorsum obtuse-angulate. Alar organs well developed; tegmina narrow-lanceolate, acute at apex; wings with specialized transverse veinlets of the first vannal area present; moderately marked alar fenestrate area present. Prosternal process thick longitudinally, retrorse, compressed, apex blunt acute. Interspace between mesosternal lobes subequal to that between the metasternal lobes. No Krauss' organ present. Caudal tibiae with internal marginal spines longer than the external ones, strongly incurved toward tibial axis, margin of caudal tibiae between spines markedly carinate. No median furcula present in male. Subgenital plate of male acutely produced, not divided at apex.

Phallic characters of the tribe.—Endophallic plates dorso-ventrally broad, highly arcuate in dorsal outline; aedeagal process strongly flexed, slender; gonopore process slender. Dorsal aedeagal valves small; weakly arcuate in lateral outline; bases expanded and recurved; apices obliquely truncate; without sculpturation or processes. Ventral aedeagal valves greatly reduced, existing as fleshy lobes. Cingulum membranous; apodemes broad, but very short.

Epiphallus proportionately large, with a prominent median protuberance on dorsal face of bridge. Lophi large, each with a prominent antero-laterally directed, mammillate process at the apex. Lateral plates well developed. Ancorae moderately large. (See figs. 61–65.)

Female spermatheca.—The female spermatheca of *C. angustipennis* is typical in structure for the subfamily. The apical diverticulum is merely incipient, while the preapical diverticulum is short, thick and apically recurved. (See fig. 62.)

Material examined.—Two species of the one included genus were examined by us: *Coryacris—C. diversipes* Rehn, **C. angustipennis* (Bruner).



Figs. 61–65. Genitalia of the tribe Coryacrini. Fig. 61—endophallus; fig. 62—female spermatheca; fig. 63—dorsal aedeagal valves (dorsal aspect); figs. 64, 65—epiphallus (dorsal and anterior aspects).

Romaleini new tribe

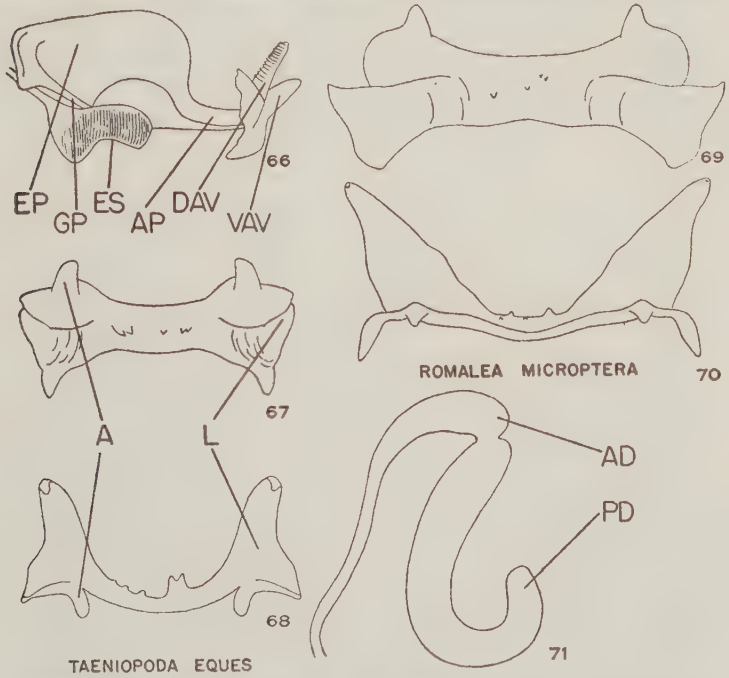
Components.—Romalea Serville, *Taeniopoda* Stål, and *Callonotacris* Rehn.

External characters of the tribe.—Brevialate to fully alate. Head not rostrately produced; fastigium with cingulate borders; well marked lateral (accessory) facial carinae present, not sinuate. Antennae with 21 to 22 articles. Pronotum with median carina tectate, intersected by all the principal transverse sulci; lateral carinae of pronotal dorsum subobsolete cephalad; prozona slightly longer than the metazona or subequal to the latter; caudal margin of pronotal dorsum rectangulate to acute-angulate produced. Tegmina well divided transversely into two sections by the first anal vein; humeral trunk well elevated. Wings with sigmoid transverse veinlets of the first vannal area well developed, their surface with minute nodulosities. Krauss' organ not developed, the area with at most only surface punctations. Prosternal process well developed, spiniform, directed caudo-ventrad.

Terminal abdominal tergite of male without distinct median furcula. Subgenital plate of male apically divided. Internal series of caudal tibial spines at most but slightly longer than those of the external series, not incurving toward the axis of the tibiae.

Phallic characters of the tribe.—Endophallic plates large, arcuate in dorsal outline; aedeagal process very heavy, weakly flexed; gonopore process slender. Dorsal aedeagal valves small, narrow, with pronounced transverse sculpturation. Ventral aedeagal valves developed, exteriorly fleshy. Cingulum weakly sclerotized; apodemes somewhat narrow.

Epiphallus with thin bridge bearing irregular dentition on dorsal face. Lophi large, apically acute, with or without a minute, tooth-like apical process. Lateral plates poorly developed. Ancorae small. (See figs. 66–70.)



Figs. 66–71. Genitalia of the tribe Romaleini. Fig. 66—endophallus; figs. 67, 69—epiphalli (dorsal aspect); figs. 68, 70—epiphalli (anterior aspect); fig. 71—female spermatheca.

Female spermatheca.—The female spermatheca in the two genera of this tribe examined for the structure, is typical for the subfamily. An incipient diverticulum is present and the preapical diverticulum is short, thickened and apically recurved (fig. 71).

Material examined.—We have analyzed the following genera and species: *Romalea*—**R. microptera* (Beauv.); *Taeniopoda*—**T. eques* (Burm.), *T. varipennis* Rehn, *T. picticornis* (Walker), *T. tamaulipensis* Rehn, *T. stali* Bruner, **T. auricornis* (Walker), *T. centurio* (Drury), *T. citricornis* Bruner, *T. gutturosa* Bol., *T. maxima* Bruner, *T. bicristata* Bruner, *T. obscura* Bruner; *Callonotacris*—*C. lophophora* Rehn.

Variation in the phallic complex.—Little variation in the phallic complex was noted between *Taeniopoda* and *Romalea*. Details of the epiphallus, especially in the form of the lophi are of help in separating the two genera (figs. 67–70).

Elaeochlorini new tribe

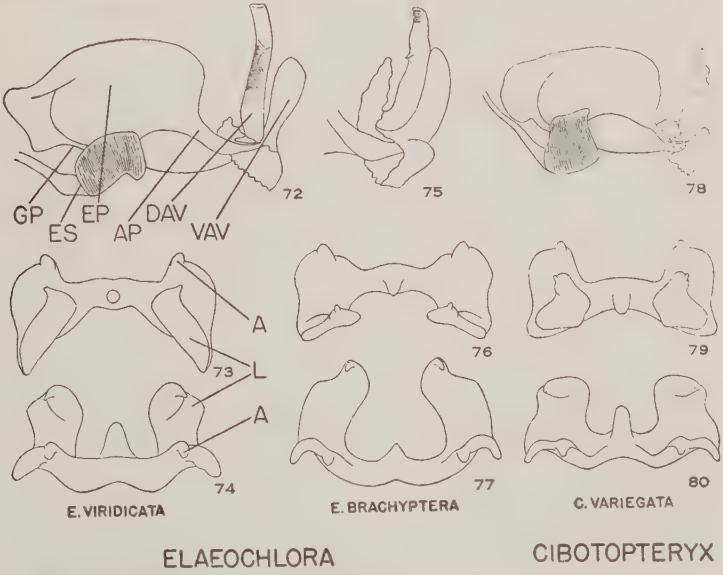
Components.—*Elaeochlora* Stål, *Agriacris* Walker, *Camposia* I. Bolívar, *Brasilacris* Rehn, and *Cibotopteryx* Rehn.

External characters of the tribe.—Form ranging from moderately compressed to robust fusiform; surface of pronotum verrucose to definitely rugose. Rostrum very short, fastigium as seen from dorsum trigonal in outline, as seen in profile but weakly projecting, neither fastigium nor occiput with a median carinula, lateral margins of fastigium low cingulate; frontal costa sulcate dorsad to the fastigio-facial angle. Antennae terete. Pronotum with median carina developed as a quadrilobate crest (*Cibotopteryx*), a tectate ridge (*Elaeochlora*), a series of tubercles or a tectation (*Agriacris*), a partially tuberculate and partly carinate elevation (*Camposia*), or a very fine carinulation involved in surface reticulations on the metazona (*Brasilacris*); caudal angle of pronotal dorsum acute-angulate to subarcuate (*Camposia* and *Brasilacris*). Alar organs ranging from fully developed and reaching to, or about to, the apices of the caudal femora (males of *Agriacris* and *Elaeochlora*) to reduced structures not reaching to the apex of the abdomen; tegmina with dorsal and lateral fields sharply defined; wings with specialized transverse veinlets of the first vannal area present; well developed alar fenestrate area present, particularly in males. Prosternal process spiniform, erect. Interspace between mesosternal lobes subequal to or narrower than that between metasternal lobes. No Krauss' organ present. Caudal tibiae with internal marginal spines much longer than the external ones, former incurved toward tibial axis. No median furcula present in male. Subgenital plate of male acuminate to subacuminate, not divided at apex.

Phallic characters of the tribe.—Endophallic plates large, dorso-ventrally broad, dorsally arcuate in outline; aedeagal process moderately to strongly flexed, slender to semi-robust; gonopore process slender. Dorsal aedeagal valves greatly elongate, with a weak to pronounced, lateral, subapical process. Ventral aedeagal valves usually large (smaller only in *Cibotopteryx*), elongate, fleshy. Cingulum membranous, with apodemes short and broad.

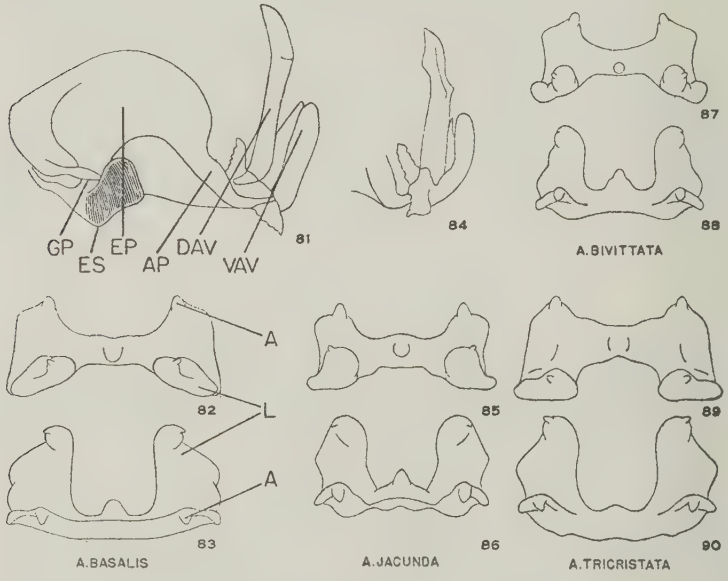
Epiphallus with a prominent, sometimes elongate median protuberance on dorsal face of bridge. Lophi large, each with a prominent, apical, mammillate process. Lateral plates large. Ancorae small. (See figs. 72–90.)

Female spermatheca.—The female spermatheca in the three genera examined for this structure (*Elaeochlora, Agriacris, Cibotopteryx*) is similar. An incipient apical diverticulum is present together with an elongate preapical diverticulum. This latter structure varies in its length, being longest in *Elaeochlora* and shortest in *Cibotopteryx*. The apex of the preapical diverticulum is apically recurved in both *Agriacris* and *Elaeochlora,* but is preapically recurved in *Cibotopteryx*. Three species of *Agriacris* (*basalis, trilineata, tricristata*) and two species of *Elaeochlora* (*viridicata, brachyptera*) were studied and found to be specifically separable on the basis of subtle characters of the spermatheca. (See figs. 91–93).



Figs. 72–80. Genitalia of the tribe Elaeochlorini. Figs. 72, 78—endophalli; fig. 75—aedeagal valves; figs. 73, 76, 79—epiphalli (dorsal aspect); figs. 74, 77, 80—epiphalli (anterior aspect).

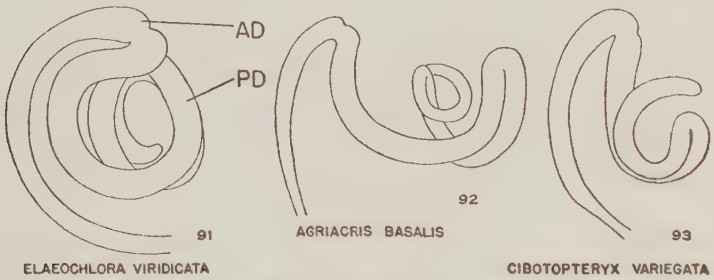
Material examined.—We have studied the following genera and species: *Elaeochlora*—**E. viridicata* (Serv.), **E. brachyptera* Bruner, **E. trilineata* (Serv.), *E. arcuata* Rehn, *E. brunnea* Hebard; *Agriacris*—**A. bivittata* (Gerst.), *A. plagiata* (Walker), **A. tricristata* (Serv.), **A. basalis* (Bruner), **A. jucunda* (Walker), *A. magnifica* Hebard; *Camposia*—*C. octomaculata* (Bol.); *Brasilacris*—*B. gigas* Rehn; *Cibotopteryx*—**C. variegata* Rehn.



Figs. 81–90. Genitalia of the tribe Elaeochlorini. Fig. 81—endophallus; fig. 84—aedeagal valves; figs. 82, 85, 87, 89—epiphalli (dorsal aspect); figs. 83, 86, 88, 90—epiphalli (anterior aspect).

Variation in the phallic complex.—The phallic structures of the genera included in this tribe and studied for these characters are all quite similar and indicate a rather close relationship among them. Of the three genera studied *Cibotopteryx* is the most distinctive, especially in the form of the dorsal aedeagal valves (see

fig. 78). Species of *Agriacris* are similar in the form of the dorsal aedeagal valves except for very subtle characteristics (figs. 81, 84). The epiphalli of this genus are easier to use in separating the species (figs. 82, 83, 85–90). Species of *Elaeochlora* differ in both epiphallic and endophallic characters (figs. 72–77).



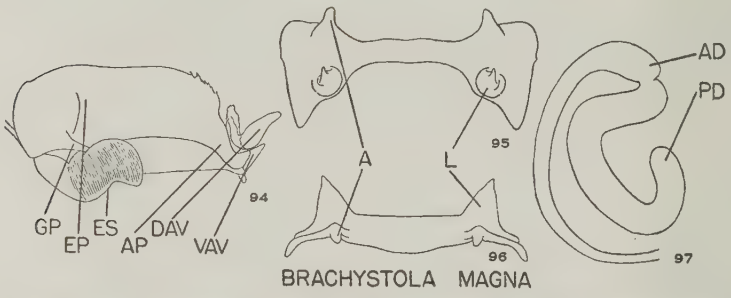
Figs. 91–93. Female genitalia (spermathecae) of the tribe Elaeochlorini.

Brachystolini new tribe

Component.—Brachystola Scudder.

External characters of the tribe.—Lobately brachyalate. Head not rostrately produced; fastigium with its lateral margins cingulately carinate, scutellum of fastigium not excavate; occiput with a weak medio-longitudinal carinula which also crosses the fastigium; lateral (accessory) facial carinae obsolete except as a brief section laterad of the antennal bases. Antennae with 24 articles. Pronotum on dorsum with no distinction of prozona and metazona, median carina distinct, entire, lateral pair similarly developed but narrowly incised by the more cephalad of the two sulci of the lateral surfaces; surface of dorsum closely and shagreenously tuberculate, of lateral lobes smooth and polished; caudal margin of dorsum transversely truncate to low arcuato-truncate. Tegmina subcircular, principal venation well marked and in relief; surface not divided transversely by first anal vein. Wings with sigmoid transverse veinlets of the first vannal area marked, strongly developed in proportion to the size of the wing. Krauss' organ not present. Prosternal process virtually absent, never more than a low node. Terminal abdominal tergite of male without distinct median furcula, the margin often erose. Subgenital plate of male very shallowly divided at apex. Internal series of caudal tibial spines stout proximad, somewhat longer than those of the external series, and appreciably incurving toward the axis of the tibia.

Phallic characters of the tribe.—Endophallic plates dorso-ventrally rather narrow, elongate; aedeagal process heavy, moderately to strongly flexed; gonopore process moderately slender. Dorsal aedeagal valves simple,



Figs. 94–97. Genitalia of the tribe Brachystolini. Fig. 94—endophallus; figs. 95, 96—epiphallus (dorsal and anterior aspects); fig. 97—female spermatheca.

apically subacute, bases recurved. Ventral aedeagal valves developed, exteriorly sclerotized. Cingulum membranous, with a thinner, narrow dorsomedian membrane.

Epiphallus with a simple, thickened bridge. Lophi small, apically acute, with or without a very small tooth-like apical process. Lateral plates well developed. Ancorae small. (See figs. 94–96.)

Female spermatheca.—The female spermatheca is typical for the subfamily. The apical diverticulum is incipient and the preapical diverticulum short, thickened and apically recurved (fig. 97).

Material examined.—We have examined the following species of the genus *Brachystola*—**B. magna* (Girard), **B. mexicana* Bruner, *B. ponderosa* Bruner, *B. eiseni* Bruner, *B. behrensi* Scudd.

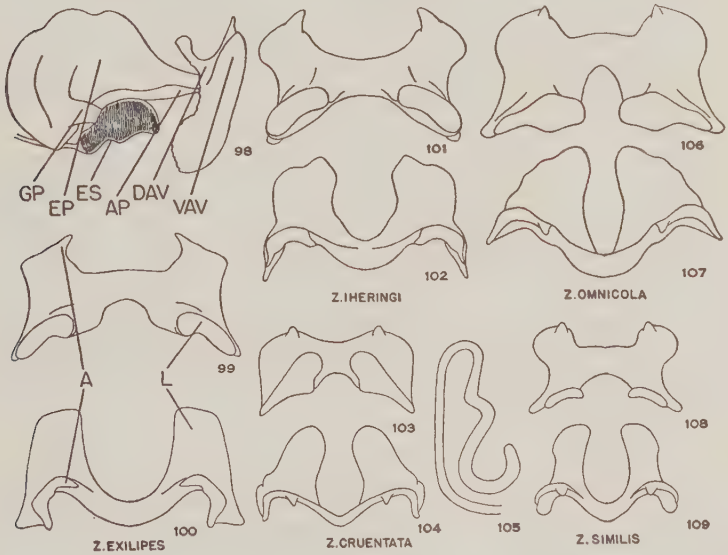
Variation in the phallic complex.—Little variation was noted in the phallic complex of the two species examined. *B. magna* differs from *B. mexicana* in epiphallic details, very subtle characters of the dorsal aedeagal valves and aedeagal process of the endophallic plates.

Zoniopodini new tribe

Component.—*Zoniopoda* Stål.

External characters of the tribe.—No definite rostral production; fastigiofacial angle in profile bluntly rounded; scutellum of fastigium not distinctly

excavate, its surface weakly impresso-punctate as contrasted with the much smoother occiput, the two separated by a transverse impression, no median carinula present, lateral margins of fastigium weakly cingulato-carinulate; frontal costa extending ventrad over face, entirely or in greater part sulcate, dorsad but weakly separated from the fastigial surface. Antennae terete. Alar organs fully developed; wings with almost no development of specialized transverse veinlets in the first vannal area, alar fenestrate area moderately developed. Prosternal process erect, acuminate, subcompressed. Interspace between mesosternal lobes subequal to or slightly narrower than that between metasternal lobes. No Krauss' organ present. Caudal tibiae with internal marginal spines but slightly longer than the external ones, the former slightly incurved toward the tibial axis. Male with definite median furcula. Subgenital plate of male acuminate, narrowly divided at apex.



ZONIOPODA

Figs. 98–109. Genitalia of the tribe Zoniopodini. Fig. 98—endophallus; figs. 99, 101, 103, 106, 108—epiphalli (dorsal aspect); figs. 100, 102, 104, 107, 109—epiphalli (anterior aspect); fig. 105—female spermatheca.

Phallic characters of the tribe.—Endophallic plates small, dorso-ventrally very broad and irregularly arcuate in dorsal outline; aedeagal process not flexed, heavy; gonopore process very heavy. Dorsal aedeagal valves small, simple, bases strongly developed and upcurved. Ventral aedeagal valves

well developed, elongate, fleshy. Cingulum moderately to heavily sclerotized; zygoma imperfect, with a narrow median membranous area; apodemes relatively narrow and elongate; rami well developed.

Epiphallus proportionately large. Lophi massive, lacking an apical process. Lateral plates large. Ancorae variable in size. (See figs. 98–109.)

Female spermatheca.—Among the species of *Zoniopoda,* this structure is so similar as to be of little use in differentiating them. It is atypical for the subfamily in totally lacking an apical diverticulum. The preapical diverticulum is apically recurved[9] and quite thin, being almost imperceptibly thicker near the apex than in the basal portion. All the species examined (*cruentata, iheringi, omnicola, tarsata, exilipes*) exhibited the characteristic subapical twist depicted in fig. 105.

Material examined.—The following species of the single included genus have been studied in the course of this work: *Zoniopoda*—**Z. tarsata* (Serv.), **Z. cruentata* (Blanch.), **Z. similis* Bruner, **Z. iheringi* Sauss. and Pict., *Z. mimicula* Rehn, *Z. hempeli* Bruner, *Z. fissicauda* Bruner, *Z. collaris* Bruner, **Z. exilipes* Bruner, **Z. omnicola* (Blanch.).

Variation in the phallic complex.—All species of the genus *Zoniopoda* are basically similar in phallic structure. Certain subtle differences occur in the endophallus chiefly in the form of the ventral aedeagal valves and endophallic plates. While the base of the dorsal aedeagal valves is highly developed it is remote from the zygoma of the cingulum and connected to it only by a thin membrane. The principal variation found among the species is in the form of the epiphallus, especially the lophi. (See figs. 99–104, 106–109.)

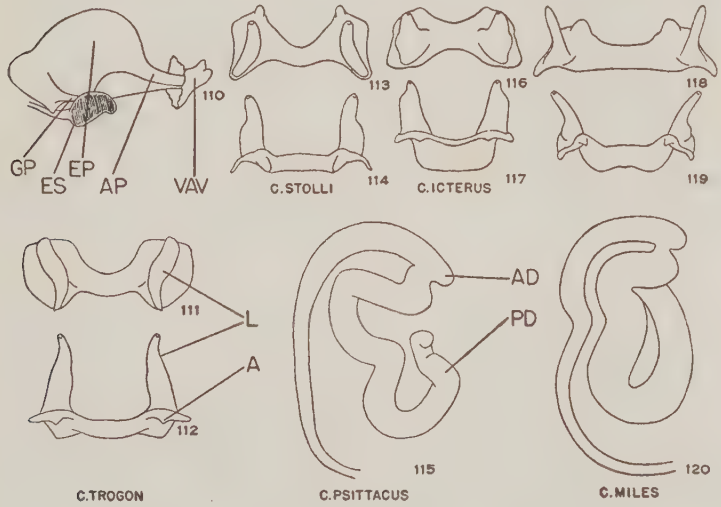
Chromacrini new tribe

Components.—*Chromacris* Walker and *Xestotrachelus* Bruner.

External characters of the tribe.—Form subcompressed (males of *Chromacris*) to subfusiform. No definite rostral production; fastigio-facial angle rounded in profile; scutellum of fastigium sulcately passing without break into the sulcus of the frontal costa, the sulcation of which is at least evident dorsad of the median ocellus (obsolete ventrad of latter in *Chromacris*); lateral margins of fastigium weakly carinate, surface of fastigium divided from that of occiput by a transverse impression, no median carinula present. Antennae simple. Pronotum with all transverse sulci deeply impressed

[9] The form of the preapical diverticulum of *Z. cruentata* figured by Slifer (Journ. Morph., 67, fig. 121 (1940)) appears to have been based on an aberrant specimen.

and entire on the dorsum, except the intra-marginal one which is narrowly broken mesad; median carina evident only on metazona, the remainder of the surface of which is rugulose; caudal angle of pronotum obtuse-angulate. Alar organs fully developed (in *Chromacris*) or shorter and not surpassing the apices of the caudal femora (*Xestotrachelus*); tegmina with dorsal and lateral fields moderately well defined; wings with transverse veinlets of the first vannal area very variable in character, ranging from numerous and clearly specialized in *Xestrotrachelus* and some species of *Chromacris* to few, simple, straight and in no way specialized in other species of *Chromacris;* alar fenestrate areas present. Prosternal process erect, spiniform, moderately aciculate. Interspace between mesosternal lobes subequal to (*Chromacris*) or narrower than (*Xestotrachelus*) that between the metasternal lobes. No Krauss' organ present. Caudal tibiae with spines of internal margin but slightly longer than those of the external margin, the former but slightly inbowed toward tibial axis. No median furcula present in male. Subgenital plate of male bluntly acuminate, apex not divided.



CHROMACRIS

Figs. 110–120. Genitalia of the tribe Chromacrini. Fig. 110—endophallus; figs. 111, 113, 116, 118—epiphalli (dorsal aspect); figs. 112, 114, 117, 119—epiphalli (anterior aspect); figs. 115, 116—female spermathecae.

Phallic characters of the tribe.—Endophallic plates small, dorso-ventrally deep and highly arcuate in outline; aedeagal process not flexed, heavy;

gonopore process moderately heavy. Dorsal aedeagal valves lacking, a weak, fleshy lobe replacing them. Ventral aedeagal valves moderately well developed, weakly sclerotized apically. Cingulum membranous, the apodemes somewhat narrowed.

Epiphallus with a simple, sometimes thickened bridge. Lophi elongate, relatively slender, each with a minute, apical, tooth-like or mammillate process. Lateral places moderately well developed. Ancorae small or obsolete. (See figs. 110–120.)

Female spermatheca.—In *Chromacris* (the only genus examined for the structure), the incipient apical diverticulum is better developed than usual in the subfamily. The preapical diverticulum is greatly thickened, apically recurved and of variable length. (See figs. 115, 120.)

Material examined.—The following genera and species of this tribe have been studied: *Chromacris*—**C. stolli* (Sauss. and Pict.); **C. colorata* (Serv.), **C. trogon* (Gerst.), **C. icterus* (Sauss. and Pict.), **C. miles* (Drury), **C. psittacus* (Gerst.), *C. peruviana* (Sauss. and Pict.), *C. latipennis* (Sauss. and Pict.), *C. nuptialis* (Gerst.); *Xestotrachelus*—*X. robusta* (Bruner).

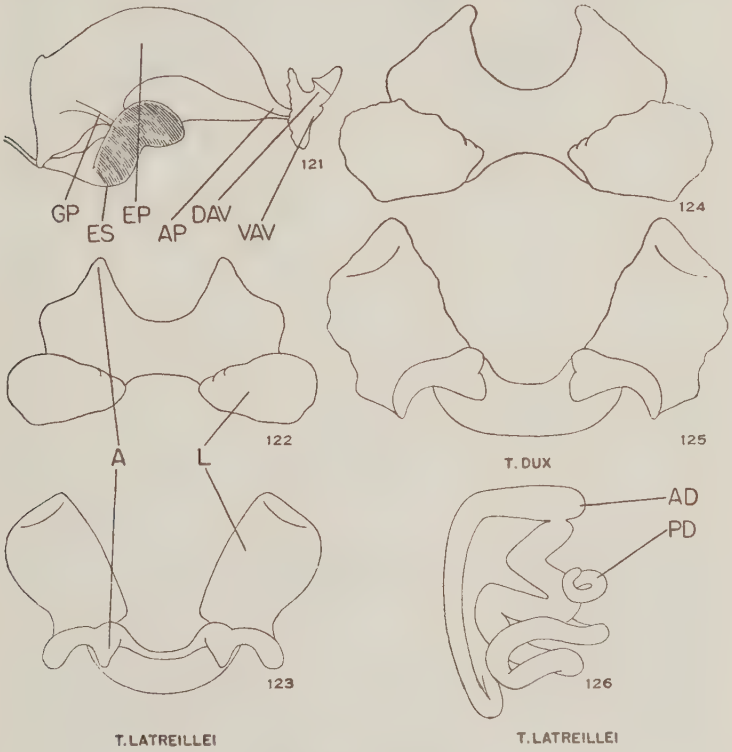
Variation in the phallic complex.—Only one genus (*Chromacris*) was studied for phallic characters. The endophallus varies so slightly as to be of little use in systematic work. The epiphallus, however, was found to have reliable taxonomic characters, especially in the form of the lophi. (See figs. 111–114, 116–119.)

Tropidacrini new tribe

Components.—*Lophacris* Scudder, *Titanacris* Scudder, *Tropidacris* Scudder, and *Eutropidacris* Hebard.

External characters of the tribe.—Form subcompressed. No definite rostral development; fastigium strongly and roundly declivent, passing evenly into the frontal costa, which latter is obsolete ventrad of the median ocellus; lateral fastigial margins at most only cingulate; fastigium and occiput without a medio-longitudinal carinula. Antennae terete. Pronotum low cristate throughout or on prozona alone, transverse sulci indicated or deeply impressed. Alar organs fully developed, much surpassing the abdominal apex; wings with definite development of specialized transverse veinlets in the first vannal area; alar fenestrate areas moderately developed. Prosternal process spiniform and erect or slightly to moderately retrorse and compressed to a variable degree. Interspace between the mesosternal lobes subequal to or narrower than that between the metasternal lobes. No Krauss' organ present. Caudal tibiae with internal

spines somewhat, but not markedly, longer than the external ones, internal spines slightly incurved toward tibial axis. No median furcula present in the male. Subgenital plate of male acuminate, apex entire to weakly notched.



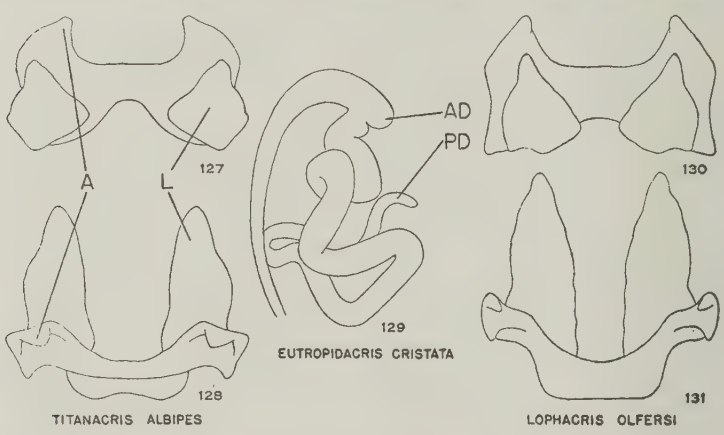
TROPIDACRIS

Figs. 121–126. Genitalia of the tribe Tropidacrini. Fig. 121—endophallus; figs. 122, 124—epiphalli (dorsal aspect); figs. 123, 125—epiphalli (anterior aspect); fig. 126—female spermatheca.

Phallic characters of the tribe.—Endophallic plates of medium size, arcuate in dorsal outline; aedeagal process stout, weakly flexed; gonopore process slender. Dorsal aedeagal valves small; with a subapical, lamellate projection continuous except on medial face. Ventral aedeagal valves very small, fleshy. Cingulum reduced, entirely membranous.

Epiphallus extraordinarily large in relation to endophallus. Bridge simple. Lophi massive, each with a blunt, low, subapical ridge on the anterior face or simple, lacking the ridge. Lateral plates relatively small. Ancorae very large. (See figs. 121–131.)

Female spermatheca.—The female spermatheca of only two genera and species of this tribe has been examined (*Tropidacris latreillei, Eutropidacris cristata*). These agree in having a pronounced incipient apical diverticulum. The form of the preapical diverticulum is atypical for the subfamily in being quite elongate and only preapically recurved. (See figs. 126, 129.)



Figs. 127–131. Genitalia of the tribe Tropidacrini. Figs. 127, 130—epiphalli (dorsal aspect); figs. 128, 131—epiphalli (anterior aspect); fig. 129—female spermatheca.

Material examined.—We have studied the following genera and species of this tribe: *Lophacris*—*L. gloriosa* Heb., **L. olfersi* (Burm.), *L. humboldti* Scudd.; *Titanacris*—**T. albipes* (De Geer); *Tropidacris*—**T. latreillei* (Perty), **T. dux* (Drury), *T. grandis* (Thunb.); *Eutropidacris*—**E. cristata* (L.).

Variation in the phallic complex.—In phallic characters this tribe is homogeneous. On the basis of the endophallus alone it is doubtful if the various species could be assigned to their respective genera. To a lesser extent this is also true of the epiphallus. However, two types exist. Type one has much more slender lophi which are proportionately elongate. This type is found in *Lophacris* and *Titanacris* and these two genera cannot be separated on genitalic characters (figs. 128, 131). Type two has

much broader lophi, each with a characteristic subapical ridge on its anterior face. This type is found in *Tropidacris* and *Eutropidacris,* neither of which may be generically separated on characters of the genitalia (figs. 123, 125).

Thrasyderini new tribe

Components.—Thrasyderes I. Bolívar and *Aplatacris* Scudder.

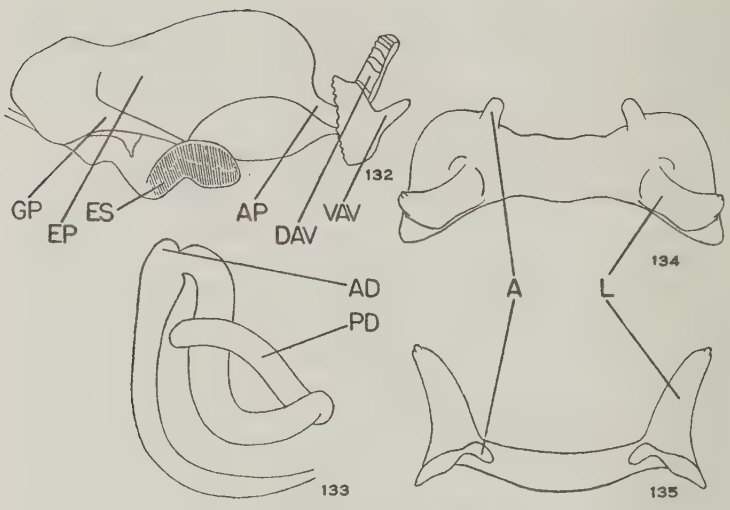
External characters of the tribe.—Form subcompressed. No definite rostral development; fastigium declivent, roundly so in *Thrasyderes,* passing evenly into the frontal costa, which latter is either obsolete ventrad of the median ocellus (*Thrasyderes*), or distinct and sulcate for the depth of the face (*Aplatacris*); lateral fastigial margins weakly cingulate; fastigium and occiput with a weakly indicated (*Thrasyderes*) to obsolete (*Aplatacris*) medio-longitudinal carinula. Antennae terete. Pronotum low cristate on prozona, transverse sulci deeply impressed. Alar organs fully developed, but not reaching the apex of the abdomen; wings with definite development of specialized transverse veinlets in the first vannal area; alar fenestrate areas moderately developed. Prosternal process spiniform and erect or slightly retrorse. Interspace between the mesosternal lobes narrower than that between the metasternal lobes. No Krauss' organ present. Caudal tibiae with internal spines somewhat longer than the external ones, slightly incurved toward tibial axis. No median furcula present in the male. Subgenital plate of male subacuminate, apex entire.

Phallic characters of the tribe.—Endophallic plates elongate, dorso-ventrally rather narrow; aedeagal process stout, moderately flexed; gonopore process slender. Dorsal aedeagal valves robust; with prominent transverse sculpturation and a smooth, weak concavity on ventral (posterior) face. Ventral aedeagal valves small, weakly sclerotized. Cingulum well sclerotized; apodemes somewhat narrow.

Epiphallus with thickened, simple bridge. Lophi horn-like, elongate, each with an apical, sclerotic boss and a subapical, minute mammillate process on the latero-ventral face. Lateral plates well developed. Ancorae large. (See figs. 132–135.)

Female spermatheca.—This structure is typical for the subfamily. The apical diverticulum is merely incipient, while the preapical diverticulum is thickened, slightly elongate and apically recurved. (Fig. 133.)

*Material examined.—Thrasyderes—*T. leprosus* Bol.; *Aplatacris—A. robertsi* Rehn.



THRASYDERES LEPROSUS

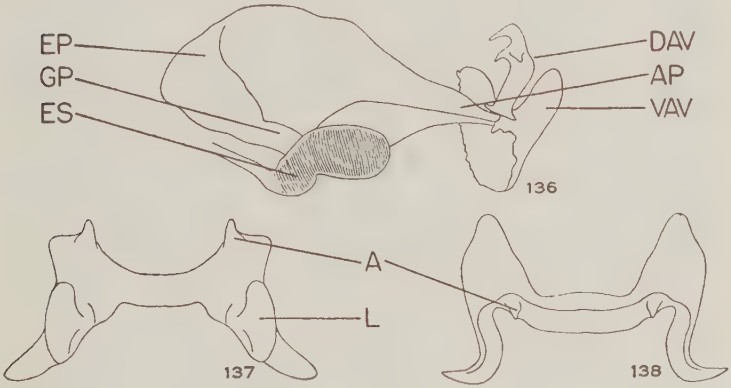
Figs. 132–135. Genitalia of the tribe Thrasyderini. Fig. 132—endophallus; fig. 133—female spermatheca; figs. 134, 135—epiphallus (dorsal and anterior aspects).

Chariacrini new tribe

Component.—Chariacris Walker.

External characters of the tribe.—Form subcompressed. Surface of face, ventral portion of genae, pronotum and pleura densely impresso-rugulose. No definite rostral development; fastigio-facial angle in profile bluntly rounded; scutellum of fastigium not excavate, its surface rugulose and differentiated from the smoother occiput; no median carinula present on fastigium or occiput; lateral margins of fastigium finely cingulate; surface of fastigium faintly (♂) or not at all (♀) cut off from that of the frontal costa, which reaches ventrad only to the median ocellus. Antennae terete, very long, in the male subequal to twice the length of the head and pronotum united. Alar organs fully developed; tegmina very narrow in male; wings with specialized transverse veinlets of first vannal area well developed; alar fenestrate areas well developed. Prosternal process spiniform, erect, aciculate. Interspace between the mesosternal lobes slightly broader than that between the metasternal lobes in the male, narrower in the female. No Krauss' organ present. Caudal tibiae with the internal margi-

nal spines very distinctly larger than the external ones, the former distinctly incurved toward the tibial axis. Furcula of male enormously developed as a pair of slender, elongate, subparallel digitiform processes surpassing the apex of the supra-anal plate and virtually reaching to the apex of the subgenital plate. Subgenital plate of male aciculately produced.



CHARIACRIS MINIACEA

Figs. 136–138. Genitalia of the tribe Chariacrini. Fig. 136—endophallus; figs. 137, 138—epiphallus (dorsal and anterior aspects).

Phallic characters of the tribe.—Endophallic plates moderately large, arcuate in dorsal outline, gently sloping ventrad posteriorly; aedeagal process robust, not at all flexed; gonopore process very heavy. Dorsal aedeagal valves large, highly specialized; each with an anteriorly recurved, acute, apical hook, a smaller, acute, subapical tooth-like process on the anterior face, and on the same level a blunter, ventro-laterally projecting tooth-like process; bases flared laterally. Ventral aedeagal valves well developed, fleshy. Cingulum membranous.

Epiphallus with a simple bridge. Lophi large, without a process. Lateral plates very large, produced ventrad of bridge and flaring laterad as broad lobes. Ancorae small. (See figs. 136–138.)

*Material examined.—Chariacris—*C. miniacea* (Gerst.).

Diponthini new tribe [10]

Components.—*Diponthus* Stål and *Gurneyacris* Liebermann.

External characters of the tribe.—Form little compressed. No rostral development; fastigium passing into frontal costa without interruption; fastigial lateral margins rounded, not carinate; frontal costa ventrad marked to clypeal suture, usually sulcate ventrad of median ocellus. Antennae terete. Pronotum rounded transversely, principal transverse sulcus the sole one completely impressed; caudal margin of pronotal dorsum rounded obtuse. Alar organs fully developed; wings without specialized transverse veinlets in the first vannal area, no alar fenestration. Prosternal process moderately to marked retrorse; distinctly compressed, subangulate at apex as seen in profile. Interspace between mesosternal lobes narrower than that between the metasternal lobes. No Krauss' organ present. Caudal tibiae with spines of both margins relatively short, those of internal series but slightly longer than those of the external margin, the former with no marked incurving. Male with no median furcula; male cerci subfalcate instead of straight. Subgenital plate of male elongate poculiform with entire spout-like apex.

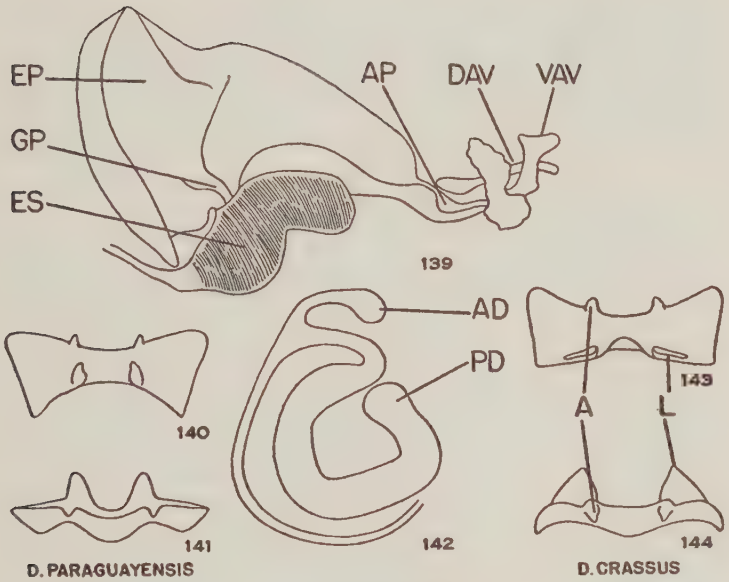
Phallic characters of the tribe.—Endophallic plates large, dorso-ventrally very broad anteriorly, greatly narrowing posteriorly; aedeagal process constricted before apex, slender, moderately flexed; gonopore process moderately strong. Dorsal aedeagal valves simple, elongate, slender, horizontal in position, arcuate in outline (except in *Gurneyacris* where they are upturned). Ventral aedeagal valves well developed, projecting dorsad of the dorsal valves on either side; apically compressed. Cingulum membranous; apodemes short.

Epiphallus very small relative to the size of the endophallus. Bridge thickened, simple. Lophi small, lobiform or apically subacute. Lateral plates large. Ancorae of medium size. (See figs. 139–144.)

Female spermatheca.—This structure is atypical for the subfamily in that it possesses a well developed apical diverticulum. The preapical diverticulum is typical in form—little elongate, thickened, and apically recurved. (Fig. 142.)

Material examined.—The following species were examined by us: *Diponthus*—**D. paraguayensis* Bruner, **D. argentinus* Pict. and Sauss., *D. clarazianus* Pict. and Sauss., **D. permistus* (Serv.), *D. pycnostictus* Pict. and Sauss., *D. festivus* Gerst., **D. crassus* Bruner, *D. electus* (Serv.), *D. paulista* Rehn, *D. bilineatus* Rehn;

[10] In 1956 (Trans. R. Ent. Soc. London, 108), Dirsh figured the epiphallus of *Diponthus paraguayensis* on plate 44, indicating that the species and presumably the genus belonged to "ungrouped genera of certain Catantopinae . . . ." We do not concur in this opinion. The phallic complex of the genus is aberrant, but is basically romaleine.



Figs. 139–144. Genitalia of the tribe Diponthini. Fig. 139—endophallus; figs. 140, 143—epiphalli (dorsal aspect); figs. 141, 144—epiphalli (anterior aspect); fig. 142—female spermatheca.

Gurneyacris—G. nigrofasciata (known to us only from the literature [11]).

Variation in the phallic complex.—The endophallus of species in the genus *Diponthus* varies very little. Subtle differences may be noted in the outline of the ventral aedeagal valves. The epiphallus offers characters for separating the species especially in the form of the lophi (figs. 140–141, 143–144). These are of two types. Type one has the lobiform lophi more or less at right

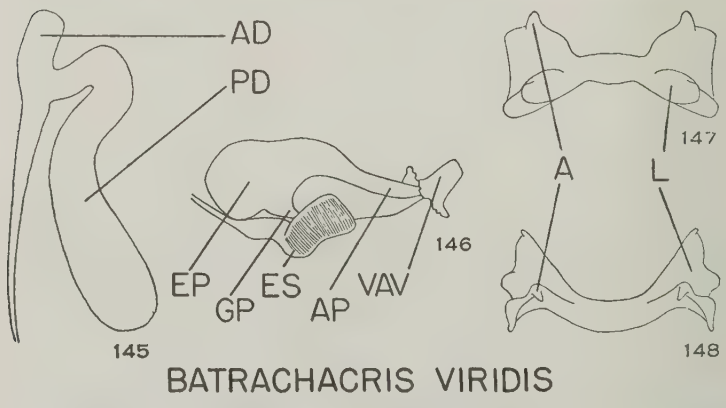
[11] The male genitalia of this species are figured in the description (Revista de Investigaciones Agricolas, XII(4), pp. 420, 421 (1958)) and may be easily compared with those of *Diponthus* presented here. Liebermann's interpretation of some aspects of the morphology of the phallic complex appears to be faulty. What he considers the rami of the cingulum we regard as the ventral aedeagal valves.

angles with the long axis of the epiphallus (found in *D. paraguayensis, D. permistus, D. argentinus* and *Gurneyacris nigrofasciata*). Type two possesses lophi which are apically subacute and positioned more or less parallel to the long axis of the epiphallus (*D. crassus*).

Batrachacrini new tribe

Component.—Batrachacris Uvarov.

External characters of the tribe.—Build stocky, form not at all compressed. All body surfaces conspicuously impresso-punctate and moderately pilose. Head subrostrately produced, fastigium trigonal in dorsal view, declivent; facial line little concave; frontal costa becoming obsolete much ventrad of the median ocellus. Lateral (accessory) facial carinae marked, straight, diverging ventrad. Antennae terete. Pronotum tectate; median carina intersected by a single, deep, transverse sulcus defining the metazona; caudal margin of pronotal disk weakly concavo-truncate. Completely apterous. Prosternal process erect, spiniform, anterior surface plane or subdeplanate. Interspace between mesosternal lobes wider than that between the metasternal lobes. No Krauss' organ present. Caudal tibiae with spines of internal margin scarcely longer than those of the external margin, the former almost imperceptibly inbowed toward the tibial axis. No median furcula present in male. Subgenital plate of male acuminate, divided at apex.



Figs. 145–148. Genitalia of the tribe Batrachacrini. Fig. 145—female spermatheca; fig. 146—endophallus; figs. 147, 148—epiphallus (dorsal and anterior aspects).

Phallic characters of the tribe.—Endophallic plates small, dorso-ventrally narrow, sloping ventrad posteriorly; aedeagal process stout, not at all flexed; gonopore process moderately heavy. Dorsal aedeagal valves absent. Ventral aedeagal valves developed, fleshy. Cingulum membranous.

Epiphallus small. Lophi robust, subacute, each with a small, apical, mammillate process. Lateral plates well developed. Ancorae small. (See figs. 146–148.)

Female spermatheca.—This structure is atypical for the subfamily. Apical diverticulum moderately well developed, thickened. Preapical diverticulum short, thickened, weakly recurved apically. (Fig. 145.)

Material examined.—*Batrachacris*—**B. viridis* (Blanch.).

THE CENTENNIAL NUMBER

INTRODUCTION

It is fitting that the Centennial year should close with the appearance of this number. In one way it is a summation of one hundred years of work. In another it is an expression of faith in the future. With few advantages, but unlimited opportunities, the men discussed in the following essays did much to mold the course of American entomology. With many advantages and even greater opportunities we are challenged by the next one hundred years. Perhaps these histories will stimulate us as examples of what can be done by determined and dedicated men.

MARGARET SMITH GRANT, *Editor*

NAMES OF OFFICERS AND THEIR TERMS OF OFFICE FROM 1909 TO 1959 [1]

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Dr. Harry W. Allen, 1956–1957	2

[1] The names of officers of the Society from 1859 to 1908 were published in "A History of the American Entomological Society," 1909.

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	Years
Mr. E. T. Cresson, 1909–1924	16
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Mr. James A. G. Rehn, 1931–1959	29

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Dr. H. Radclyffe Roberts, 1942	1
Dr. A. Glenn Richards, Jr., 1943–1945	3
Dr. Charles Hodge, IV, 1946–1947	2
Mr. Raymond Q. Bliss, 1948–1949	2
Mr. Ray Kennelty, 1950–1951	2
Mr. Joseph C. Kopf, 1952	1
Dr. V. S. L. Pate, 1953–1954	2
Mr. Fred B. Jacobson, 1935	1
Mr. Harold J. Grant, Jr., 1956–1959	4

THE INFLUENCE OF THE AMERICAN ENTOMOLOGICAL SOCIETY UPON THE STUDY OF HYMENOPTERA

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The purpose of this paper is, in the first place, to demonstrate what success exposure to the ideals, associations, and material resources of the American Entomological Society has met in stimulating Philadelphians to undertake productive research on Hymenoptera, to evaluate the work that they have accomplished, and to indicate in what instances these stimuli have had a life-long, or at least extended, influence even in some instances after the individuals concerned have left the folds of their mother society. The stimulation of such research has been, of course, far more than a local or even national matter, for the results are woven into the mesh of world-wide zoological knowledge.

The second purpose is to show to what extent the early *Proceedings* of the Society, and the still current *Transactions* and *Memoirs* have advanced hymenopterology by providing a dignified and universally recognized source for publication of the results of the research, not only of the members of the Society, but of any qualified hymenopterist.

Finally, lest it be forgotten by on-coming generations, it is worth-while putting into words the fact, well known to older hymenopterists, that the principal share of pioneer work on the taxonomy of American Hymenoptera was done by members of the Society. The acquisition of the vast collections of Cresson, Blake, Bassett, and Fox, including in these and from other sources the types of around 3700 nominal species, has provided an indispensable basis for all future work on the taxonomy of the order, at least so far as the American fauna is concerned. Taxonomists come, and will continue to come, to consult these collections and to study these types. It has always been the policy of the Society and of the Academy of Natural Sciences of Phila-

delphia to encourage such visits, to make the collections available for study, and to place the exceedingly rich libraries of both at the command of visitors for purpose of research. Of course the collections and libraries of each have always served members of the Society, and everyone has been provided with comfortable quarters and facilities for work. Through association with each other, members have acquired and maintained high standards and traditions of taxonomic work.

After the Society established its rooms in the building of the Academy of Natural Sciences, an arrangement was entered into by which all persons before being elected members had to become members of the Academy. The regular or, as it was termed, resident membership consisted therefore entirely of persons who, at the time of their election, lived in or near Philadelphia. But there was also a class of non dues-paying members who lived elsewhere and whose status was of an honorary nature. These were the corresponding members. It is obvious that the influence of the Society has been less direct upon corresponding than upon resident members. In 1924 the restriction in regard to membership in the Academy was lifted, and since that time regular members have been elected who do not and never did reside in Philadelphia. The publications of these members and of corresponding members in sources other than the *Proceedings* and *Transactions* of the Society are not noted here, since they do not reflect any direct stimulus from the Society.

In counting papers published by the Society I have disregarded those published in the *Practical entomologist* or in the *Entomological news*. This is partly because the Society was not directly responsible for the publication of the *News* until 1925, and partly because both publications are periodicals, not classified by librarians among the publications of learned societies. The shorter, rarely revisionary papers that appear in these magazines are a lesser measure of taxonomic achievement than are the more finished papers for the publication of which the *Proceedings* as well as the *Transactions* exist.

I cannot take space to evaluate thoroughly each piece of research even if I were able to do so. I might say that the taxo-

nomic work of members of the Society, and all such work which has been done at the Academy, whether by members or not, has been done sincerely, in good form, readily usable by others, and has been of high grade, when one considers the resources available at the time in which it was written.

THE PIONEER PERIOD, 1859–1889

The young Ezra Cresson, turning his attention from Coleoptera to Hymenoptera at about the time that he and some friends founded the Entomological Society of Philadelphia, laid a foundation for his future work by preparing, and in 1860–1862 publishing, a catalogue of the described North American Hymenoptera. This was a purely objective catalogue; everything described as a species was recorded under the name that had been given to it, almost without exception, and in the genus to which it had been originally assigned. There was neither subjective attempt to rectify synonymy nor to improve generic assignments. Cresson, who at that time had never described an insect, would not then have been capable of an excursion into the intricacies of synonymy. This catalogue, produced as it was by a youth of between 21 and 23 years of age with no higher education than that of a public grammar school, is a remarkable witness not only to his mental ability but to the advantage that he had taken of access to European literature available to him in the library of the Academy of Natural Sciences of Philadelphia, and of his mastery of that literature.

From that catalogue we can derive a picture of the state of knowledge of the taxonomy of Hymenoptera of our continent at a period midway between the publication of the tenth edition of the *Systema naturae* and the present time. There had then been about 1740 regional species described. Sixty-three percent had been described incidentally by Europeans in general descriptive papers, occasionally in papers restricted to particular families, none in papers directed especially to the American fauna. Of the 625 species described by American authors, about 380 or sixty percent had been described by Thomas Say, himself an earlier Philadelphian, the remaining 245 chiefly by T. W. Harris in 1842 in his Insects of Massachusetts, and by a Pennsylvanian, S. S.

Haldeman, who, although a corresponding member of the Entomological Society of Philadelphia, died the year that it was founded. Say had published three papers devoted to descriptions of American Hymenoptera, Haldeman four. Many of the common species of the eastern United States had been made known, but almost nothing was known of those native to the great lands west of the Mississippi River, except for some that Say had described from the Long Expedition.

The year following the founding of the Society, two papers were published (but not by the Society) that were the first that had ever comprehensively reviewed the taxonomy of any family or even genus of American Hymenoptera. One was a review of the Bombidae, not by a member of the Society, the other was a synopsis of the sawfly genus *Allantus*, the first publication of Edward Norton. The following year Norton was elected a corresponding member of the Society and he contributed four papers to the first volume of its *Proceedings*, mostly descriptive of sawflies, but one of them revising certain genera of ichneumon-wasps. Edward Norton was born in Albany, New York, in 1823. He was a graduate of Yale University and lived at Farmington, Connecticut where he was a noted breeder of fine cattle. He had traveled in Europe but whether he met entomologists there I do not know. In subsequent years he contributed four more important and scholarly papers to the publications of the Society. These included his "Catalogue of the described Tenthredinidae and Uroceridae of North America". Norton is chiefly remembered for his work on sawflies and horntails, of which he described 290 nominal species as against 175 described by Cresson. The two men together laid the principal groundwork for our knowledge of the North American fauna of that suborder. Norton's last paper was a revision of the Chrysididae which appeared in the *Transactions* of the Society in 1879. He died in 1894.

In the early years of the Society three corresponding members were establishing a knowledge of American Cynipidae. The first of these was Carl Robert freiherr von der Osten Sacken, then Secretary of the Russian Legation in Washington, who was elected a corresponding member of the Society in 1859, and contributed to the first volume of the *Proceedings* a synopsis of the North

American oak galls with keys to the galls but not to the gall-makers. The Baron supplemented this work with three further papers on Cynipidae in subsequent volumes of the Society's publications, the last appearing in 1870. Osten Sacken was born in 1828 in St. Petersburg, Russia, came to the United States in 1856, and went to live in Heidelberg, Germany in 1877, where he died in 1906.

Homer Franklin Bassett was born in Massachusetts in 1820 and attended Oberlin College. For some years he maintained a private school in Waterbury, Connecticut, and from 1872 until the year before his death in 1902 was librarian of the Bronson Library in that city. He was elected a corresponding member of the Society in 1863 and published his first paper, descriptive of new Cynipidae, in the second volume of the *Proceedings* of the Society in that year. This was followed by two more in the third volume. Most of his numerous descriptions of gall-wasps were published elsewhere, but in 1889 he published a final paper in the *Transactions* also descriptive of new species. His important collection of these insects and their galls was presented to the Society just before his death in 1901. It includes the types of 125 species, a catalogue of which, compiled by E. T. Cresson, Jr., was published by the Society in 1922.

The third worker on Cynipidae was Benjamin Dann Walsh who was elected a corresponding member in 1861, and contributed an important paper to the second volume of the *Proceedings*, published in 1864. It was entitled "On dimorphism in the hymenopterous genus *Cynips*, with an appendix containing hints for a new classification of Cynipidae, and a list of Cynipidae, including descriptions of several new species inhabiting the oak-galls of Illinois". Walsh later published two papers on sawflies in the fifth and sixth volumes of the *Proceedings*. He was born in England in 1808, graduated at Trinity College, Cambridge, and came to America in 1838, where he eventually became State Entomologist of Illinois. Unlike most of his contemporaries, he thus became for a short period a professional entomologist. He died in 1869 as the result of an accident.

Ezra Townsend Cresson, leading spirit in the founding of the Society, whose first catalogue of North American Hymenoptera

has already been mentioned, stands far above all others as the pioneer hymenopterist of North America. He was born in Philadelphia in 1838 of quaker ancestry. Except for eight years as curator of the Society, he was, like most of his contemporaries, reluctantly an amateur, having been employed for forty-one years by the Franklin Insurance Company of which he was the Secretary for a long period. He died in 1926. All but seventeen of his papers were published in the *Proceedings* or *Transactions* of the Society. His first descriptive paper appeared in the second volume of the *Proceedings* in 1862 and was a description of *Masaris vespoides*. Within the next nineteen years he published sixty-three more papers. He worked in all sections of the order except with the ants and the proctotrypids. The majority of his papers were collections of descriptions of new species, twenty-eight of these miscellaneous, eight descriptive of bees, five of wasps, two of Mutillidae, nineteen of Ichneumonoidea, and one of sawflies. Some twelve papers were faunistic studies, catalogues, or lists. The most important of the latter were those on the Hymenoptera of Cuba (1864, 1869); the Hymenoptera of Colorado Territory (1865); the Hymenoptera Texana (1872); and five papers on the Hymenoptera of Mexico. The Hymenoptera of Colorado was based on material collected by a member of the Society, James Ridings, Cresson's father-in-law. The Hymenoptera Texana, a work of 140 pages, enumerated over 600 species, half of them newly described. His interest in that fauna arose from a residence of a few months during 1859 in New Braunfels, which he had expected would be permanent.

Cresson wrote but few revisionary works that included keys to the known species, but the half dozen that he did write were of excellent quality, as was all of his work. In 1888 he terminated his taxonomic work on the North American fauna with his well-known "Synopsis of the families and genera and Catalogue of the described Hymenoptera of America north of Mexico," but in 1902 he published in the *Transactions* a long and very important paper on the Mutillidae of Brazil, and in 1916 the Society published as a *Memoir* the catalogue which he had prepared of the types of the 2,737 nominal species that he had described during his lifetime. The greatest number of his species are ichneumon-

wasps, the bees coming next with over half a thousand. Finally, putting the house in order for future students, he prepared a manuscript catalogue of all types of Hymenoptera other than his own in the Society's collection, which was published as a *Memoir,* but posthumously. Cresson never published on the habits or immature stages of Hymenoptera and made no mark as a field-naturalist.

Returning to the early days of the Society we find four other resident members who published papers on Hymenoptera. The first and foremost of these was Charles Alfred Blake who was born in England in 1834 and educated at the Naval School in Greenwich. He came to America in 1849 and became a manufacturer of surgical and dental instruments. He joined the Society in 1860, took an active part in printing the publications, and served for many years as corresponding secretary and librarian. His three publications, all of which appeared in the *Transactions,* were on Mutillidae, the first one in 1872. The last one, a monograph of the North American species, appeared in 1886. He died in 1903.

Another resident member of the Society to become interested in Hymenoptera was Samuel Francis Aaron. Born in Mt. Holly, New Jersey three years after the founding of the Society, Aaron lived as a boy in Tennessee, and when sixteen years of age made a hunting trip into southwestern Texas collecting insects along the Gulf Coast between the Colorado River and Corpus Christi. He came of a family interested in entomology, for his father was a corresponding member of the Society and his older brother, from 1883 to 1884, its curator. He himself was once Curator of the Entomological Section of the Academy of Natural Sciences. He took up the study of Chrysididae where Norton had left it, and it is recorded that he had available for study not only Norton's collection but also Provancher's types and, of course, other material in the Society's collection. He published a single paper, a monograph of the Chrysididae, in 1885. Subsequently Aaron became Curator of Insects in the Philadelphia Commercial Museum. He died in 1947.

The third of the early hymenopterists in the Society was the Reverend Doctor Henry Christopher McCook who became an

active member in 1877, seven years after he had been called to the pastorate of the Tabernacle Presbyterian Church of Philadelphia. The interests of Dr. McCook, unlike the other hymenopterists of the Society, lay not in taxonomy, but wholly in the habits and architecture of ants. His first two papers were published in 1876 and 1877 respectively, in the *Transactions,* but he subsequently published elsewhere twenty-five papers in all. Although he took an active interest in the Society, of which he served as Vice-President for ten years and President for three, it is doubtful that his association there was the active stimulation of his research. He died in 1911.

The fourth member was James H. McFarland, who became a resident member in 1860. I know nothing of him except that he published a Table of the genus *Vespa* of the United States in the *Transactions* for the year 1888. Although this paper appeared after Cresson's synopsis and catalogue, it logically belongs in the pioneer period.

Besides the five resident and four corresponding members noted above there were five other entomologists each of whom published one or more papers on Hymenoptera in the Society's serials during this pioneer period. Three of these were corresponding members and the other two were to be later elected.

Samuel Botsford Buckley was born near Seneca Lake in western New York in 1809, graduated from Wesleyan University, and lived in Austin, Texas where he became State Geologist in 1866. In 1862 he was elected a corresponding member of the Society and contributed a rather popular account of the habits of the tarantula-hawk, *Pepsis,* to the first volume of the *Proceedings.* Afterwards he published descriptions of new species of ants in the sixth volume. He died in 1884.

William Couper, a pioneer naturalist of Canada, came from England in 1842 as a printer. Later he became a commercial naturalist, and in 1865 Curator of the Quebec Branch of the Entomological Society of Canada. In 1862 he was elected a corresponding member of the Society and contributed a paper on tent-building ants to the first volume of the *Proceedings.* He died in Albany, New York about 1890. He and Buckley each published elsewhere a few small papers on the habits or archi-

tecture of ants or other Hymenoptera.

Alpheus Spring Packard was born in Maine in 1831, the son of a member of the faculty of Bowdoin College where he graduated in 1861. That same year he was elected a corresponding member of the Society and also became Entomologist of the Scientific Survey of Maine. After a varied professional career he was called to Brown University as Professor of Zoology and Geology. He died in 1905. Packard published a revision of the Crabronidae and Nyssonidae of North America in the sixth volume of the *Proceedings*, important historically because it was a very early revisionary paper, now largely superseded. No more of his numerous papers were published by the Society.

William Harris Ashmead was born in Philadelphia in 1855. He subsequently removed to Florida where he entered business as a book-seller. In 1897 he became an assistant curator in the United States National Museum and held that position until his death in 1908. His first paper on insects was published in 1879. The first in the *Transactions* appeared in 1885, and was catalogue of North American Cynipidae. Twelve years later, in 1897, he was elected a corresponding member of the Society. His other contributions to the *Transactions* were "Synopsis of the North American subfamilies and genera of Cynipidae" (1886); "Studies of the North American Chalcididae, with descriptions of new species from Florida" (1886); "On the Cynipidous galls of Florida, with descriptions of new species and synopses of the described species of North America" (1887); "Synopsis of the Hormiinae of North America" (1893); "Descriptions of new parasitic Hymenoptera" (1894) and (1896); "Classification of the bees of the superfamily Apoidea" (1899). Ashmead's work became increasingly hasty and careless and this classification, like those of other groups that he published covering the world fauna, transcended his capabilities and has not proved satisfactory.

Leland Ossian Howard was born in 1857 in Illinois but grew up in Ithaca, New York. As a boy he developed an interest in insects that was encouraged through friendship with Professor J. H. Comstock. He graduated from Cornell University in 1877, the following year entered government service, and, eventually,

as Chief of the Bureau of Entomology became America's best-known entomologist. His death occurred in 1950 at the age of 93. Howard was the first American specialist in Chalcididae and Proctotrypidae, at least he was the first to publish, although he was contemporaneous with Ashmead. How greatly Cresson leaned on him for help with those two families when he was preparing his generic synopsis of Hymenoptera is revealed in his letters to Howard published in Calvert's biography of Cresson. Howard published a generic synopsis of the Proctotrypidae in the *Transactions* of the Society in 1866. Eleven years later he was made a corresponding member on the same day as Ashmead.

The publication of Cresson's great generic synopsis and catalogue marked the end of the pioneer era of American hymenopterology and the beginning of a new one, because then for the first time American students had a workable manual for the generic determination of their material and a catalogue of all described species. As George D. Hulst truly wrote of the Synopsis in 1887, " [It] marks an era in the mapping out of another part of the great field of American Entomology ".

TWO TRANSITION DECADES, 1888–1908

Soon enough after the publication of Cresson's synopsis and catalogue the study of Hymenoptera was again taken up in Philadelphia and greatly advanced by a young man who became assistant librarian of the Academy of Natural Sciences, William J. Fox. Although many of Fox's papers were published in sources for which the Society was not directly responsible, his work was wholly inspired by his association with the Society and its collections. His series of synopses, revisions, and even monographs of group after group of North American aculeate Hymenoptera were taxonomic work of so high caliber as to have placed him, in this country, on a level that Franz Friedrich Kohl of Vienna occupied in Europe. Many of his papers have not been replaced in the sixty or more years that have elapsed since their publication.

Nothing is recorded of Fox's early life, but the fact that his first paper dealt with a trip to Jamaica made in company with

C. W. Johnson suggests that his interest in insects may have been first aroused, or at least encouraged, by that beloved dipterist who, as is well known, initiated and nurtured an interest in insects in several boys who later became known entomologists. Fox's work on Hymenoptera was discontinued in 1898, not because of loss of interest but, I have been told, because he was officially discouraged by his superior officer from continuing it.

Fox's ten papers that appeared in the *Transactions* were 1) "On a collection of Hymenoptera made in Jamaica during April 1891" (1891, 70 species were listed); 2) "On the species of *Trypoxylon* inhabiting America north of Mexico" (1891, revised two years later); 3) "The North American Pemphredonidae" (1892, current in some genera for specific identifications); 4) "Monograph of the North American species of *Tachytes*" (1892); 5) "The North American species of *Ceropales*, with a catalogue of the described species of the World" (1892); 6) "A new genus of Larridae (*Diploplectron*)" (1895); 7 and 8) "The Crabroninae of Boreal America", with supplement in the following year (1895–1896, still our only source for specific determinations); 9) "The North American Mutillidae" (1898, replacing Blake's monograph of twelve years earlier); and 10) "The species of *Psen* inhabiting America north of Mexico" (1898). In addition to these papers Fox published revisionary papers in other serials dealing with *Astata* (1892 and 1894 *); Larrinae, and *Tachysphex** (1893); *Mellinus**, *Alysson** and *Didineis* (1894); Gorytini* (1895); *Sphecius**, and Stizini* (1895); Nyssonini* (1896). (Those which bear an asterisk are still current, at least for specific identification). Finally, beyond the American Fauna, Fox published a report on the Hymenoptera collected by Donaldson-Smith on an expedition in Africa, and a very important series of papers on the Hymenoptera collected by Herbert H. Smith during some years residence in Brazil. Certainly the facilities of the American Entomological Society can be credited as much for Fox's work that was published elsewhere as it can for that which was published by the Society.

The writer was the only other resident member of the Society who published on Hymenoptera during this period. Since this is an historical document it would be false modesty to fail to

record, objectively, something of the circumstances. Born in West Chester, Pa., in 1884, and living as a young boy on a farm in Chester County, my interest in natural history was early aroused and had the sympathetic encouragement of my parents. Moving to Philadelphia when I was ten years old, I soon found a patient and encouraging mentor in the person of the late William G. Gerhard, then a Jesup scholar at the Academy. My interest centered on Coleoptera, but at the suggestion of Mr. Gerhard, at about the turn of the century, I decided to study the Hymenoptera instead. I began by rearranging the Siricoidea and later the Evaniidae in the Cresson Collection. The first results appeared in the *Transactions* of the Society in 1901 as a brief synopsis of the Oryssidae, and in the same year a revision of the North American Aulacidae; a second revisionary paper on Evaniidae was published in 1908. The rearrangement of the Cresson collection of Siricidae did not bear fruit until 1915, but the resulting monograph of North American Siricidae was not published by the Society. Since 1903 I have, for most of the years, been connected with Cornell University, and only some of my work from time to time has been done largely in Philadelphia, directly and principally based on the collections of the Society. Here may be included three papers on the North American Mutillidae (1916); a revision of North American Myrmosidae (1917); "Descriptions and Records of Nyssonidae" (1920); and a revision of certain Pompilini of the New World (1944). All of these were published in the *Transactions* of the Society. "The taxonomy of the masarid wasps, including a monograph of the North American species" (1922) and two papers on Cresson's species of Cuban and Mexican Pompilidae, respectively, in 1944 and 1946, were not published by the Society but were largely or wholly based on material in its collection. Two further papers published in the *Transactions* were not primarily based on work done in Philadelphia. They are "A revision of the New World species of *Trielis*, a subgenus of *Campsomeris*" (1922), and "The taxa of *Campsomeris* occurring in the New World" (1957). In addition to these papers more than half a hundred papers on Hymenoptera have been published in other sources; five of these, one a revision, while I was working on the Society's collections

prior to 1903, about fifty, of which eight are revisionary, during later years in which the collections of the Society exerted no immediate stimulus.

Henry Lorenz Viereck was born in Philadelphia in 1881 and in 1901 became a Jesup scholar at the Academy of Natural Sciences. Although never an actual member of the Society, because of restricting conditions of membership then obtaining, he had a very real relation to it and derived the initial basis of his research from the Cresson Collection, to the rearrangement of which he devoted an arduous attention. He entered the Jefferson Medical College in 1903 and was there again from 1905 to 1907 but did not find medicine to his taste and never graduated. In later years he held several positions: in the Connecticut Agricultural Experiment Station, in the Pennsylvania State Department of Health in their Department of Zoology, in the U. S. Bureau of Entomology for work in taxonomy at the National Museum, in the U. S. Biological Survey, and in the Entomological Branch of the Canadian Department of Agriculture. In 1926 he returned to Philadelphia to live, and died in 1931 as the result of an accident.

J. A. G. Rehn has recounted how Viereck and he, as boys, came under the tutelage and inspiration of the late Charles W. Johnson, and of the many happy days and field trips they had together. Viereck's particular love was the wild bees, especially the genus *Andrena*, but the great work that he envisaged on that genus was never completed. Rehn has written, "In the ichneumon-flies Viereck's studies were largely of the post-pioneer type, taking work of the true pioneers, correcting evident errors and misconceptions, constructing on their foundations, and passing on to the next generation of workers a great amount of detailed study, type-comparisons, and laboriously assembled bibliographic work for the more final analyses of successors." All who knew Viereck recognized in him an idealist, but sometimes his idealism surpassed the bounds of the practical. He and the writer, as boys, spent long hours in pleasant association in the rooms of the Society, working on our respective tasks on one group or another of Hymenoptera.

Viereck's papers published in the *Transactions* of the Society

began in 1900 with "New Species of the subfamily Pseninae", and this was followed by "The Hymenoptera of Beulah, New Mexico" (1903); "Classification of the bee genus *Bombomelecta*" (1903); "The North American cuckoo-wasps of the genus *Parnopes*" (1904); "Additions to Sphegoidea" (1904); "The species of *Odontophotopsis*" (1904); "Notes and descriptions of Hymenoptera from the western United States" (1905); "New species of North American bees of the genus *Andrena* in the collection of the Academy of Natural Sciences" (1917); and "A new bee of the genus *Andrena* in the collection of the Academy of Natural Sciences of Philadelphia" (1925).

According to Rehn, Viereck published a total of ninety-two papers on Hymenoptera in a variety of sources. Perhaps his most important technical paper was his list of the genera of Ichneumonoidea with their type-species, but his most comprehensive and widely-known work is the Hymenoptera of Connecticut in which he collaborated with several other authors, and which is still the only collected source for the determination of north-eastern Hymenoptera right down to species.

No other Philadelphia entomologists were interested in the study of Hymenoptera during this period, but the *Transactions* served as a source of publication for one of the Society's corresponding members, Theodore Dru Allison Cockerell, who was born in England in 1866, became curator of the museum in Kingston, Jamaica, in 1893, later taught in the Agricultural College of New Mexico, and eventually became Professor of Entomology in the University of Colorado. He was made a corresponding member of the Society in 1904, and died in 1948. Cockerell's innumerable papers were ubiquitous, but he published eleven of them in the *Transactions* between 1895 and 1918. One of these, in 1906, was a revision of the North American Anthophoridae, a most unusual type of paper for him, for his chief taxonomic interest seemed always to lie in describing new species. The other ten papers were almost exclusively descriptive, synonymic, and faunistic papers on bees.

During these two decades, interest in the Hymenoptera was widening, and ten entomologists, in no way connected with the Society, were helped in their work by opportunity to publish

papers on Hymenoptera in the *Transactions*. In three or four instances these papers involved research partly or wholly based on the Society's collection.

The most important of these was G. C. Davis who received the degree of Master of Science at the Agricultural College of Michigan in 1896 and subsequently became Entomologist of the Michigan Agricultural Experiment Station. His excellent work on the Tryphoninae, based largely on the Cresson Collection, has remained basic for the study of those ichneumon-wasps until the present time. He published four papers in the *Transactions* in 1896 and 1897, two descriptive and two revising the Tryphoninae of North America.

Charles W. Robertson was born in 1858, studied at Blackburn University and at Harvard, and for eighteen years taught biology in Blackburn University. He lived in Carlinville, Illinois and died there in 1935. His first paper in the *Transactions* was published in 1889, a synopsis of the genus *Oxybelus*. This was followed by ten papers, almost exclusively on bees, the last of which appeared in 1905. Robertson was a careful observer with an intimate knowledge of his local fauna, but his attempt to establish a classification of bees based on one small fauna was disastrous.

The remaining ten authors, only one of whom contributed more than a single paper, follow chronologically.

Clarence Moores Weed was born in 1864. He graduated at the Agricultural College of Michigan and became Entomologist at the Ohio Agricultural Experiment Station, but for the greater part of his life he was principal of the Normal School in Lowell, Massachusetts. His single paper was descriptive of new Microgasterinae, 1888.

Clarence Porter Gillette was born and educated in Michigan under Professor Cook. He became Professor of Entomology in the Colorado State Agricultural College. In 1896 he published a monograph on the inquiline gall-wasps.

In 1897 H. W. Lewis published a revision of the Vespinae of the United States and Canada. This superseded McFarland's 1888 paper and in turn has been superseded by the recent work of Bequaert and others.

P. S. Dunning published a revision of *Aphilanthops* in 1898 which remains in use.

Beginning with the turn of the century, Peter Cameron, an English species-grinder of poor repute among taxonomists, began sending in a series of twelve papers (1900–1909) descriptive of North and South American Hymenoptera, many of them collected by Professor Carl Fuller Baker. Cameron was born in 1847 and died in 1912.

Charles Thomas Brues was born in Wheeling, West Virginia in 1879. He graduated from the University of Texas in 1901, and from 1905 to 1909 was a curator in the Milwaukee Public Museum. In 1909 he was called to Harvard University where eventually he succeeded his former teacher, Professor Morton L. Wheeler, as Professor of Entomology. In 1903 he published a paper in the *Transactions* entitled "Descriptions of new ant-like and myrmecophilous Hymenoptera". He died in 1955.

Axel Leonard Melander was born in Chicago in 1878 and graduated at the University of Texas in 1901. He took his doctorate at Harvard in 1914. From 1904 to 1926 he was head of the Department of Zoology at Washington State College, and after that head of the Department of Biology at the College of the City of New York. He is a dipterist whose sole study on Hymenoptera was published in the *Transactions* in 1903: "Notes on American Mutillidae".

Lawrence Bruner was born in Lehigh County, Pennsylvania, in 1856. He became Professor of Entomology in the University of Nebraska and trained several hymenopterists. In 1903 he published "Some notes on the bee genus Andrena" in the *Transactions*. He died in 1937.

J. C. Crawford was a hymenopterist at the United States National Museum. In 1906 he published in the *Transactions* a paper entitled "Some Costa Rican bees".

Henry Scott Smith was born in Nebraska in 1883 and graduated at the University of Nebraska in 1907. He published a paper in the *Transactions* in 1907 entitled "Contributions toward a monograph of the Ceratinidae of North and Middle America". From 1923 until his death in 1959 he was on the staff of the University of California.

With this the first half-century of the Society's existence drew to a close.

THE LAST HALF-CENTURY, 1909–1959

This may be characterized as the period of the binocular microscope which has made possible a more searching examination of the anatomy of insects than the hand-lenses used by former generations. It is also the period of the automobile and good roads, of innumerable collecting excursions made by the curators of museums, and by the faculties and students of colleges, resulting in great accumulations of research material which it has become the custom of institutions to freely loan to taxonomists when they are engaged in a revisionary or monographic study of one group or another of insects. The result has been a vast blooming of the knowledge of our Hymenoptera which the American Entomological Society and the Academy of Natural Sciences have not directly instigated (as they did, for example, in the Orthoptera) but behind which their collections, so rich in types, have remained always a solid basis for research.

No new member of the Society, resident of Philadelphia or its environs, developed there and maintained for any length of time an active interest in Hymenoptera, except, in a measure, Vernon Sennock Lyonesse-Liancour Pate who was born in Philadelphia in 1902. Just how his interest in Entomology was aroused I do not know, but he early became a member of the American Entomological Society and presumably found inspiration from the Cresson and Fox collections. He graduated from Cornell University in 1928 and published his first paper on Hymenoptera, "Studies in Oxybeline wasps", in the following year in the *Entomological news*. He became an assistant in the Department of Entomology at Cornell where he took his doctor's degree in 1946. He remained on the staff of Cornell University until 1952 when he returned to Philadelphia. He died in 1958. His work was largely confined to the sphecoid Hymenoptera and to the generic names applied to those wasps and to the Pompilidae. Between 1929 and 1948, when his last paper appeared, he published sixty-seven papers, fifteen of them in the year 1947. These were published in a wide variety of sources, many of them in the *Entomological news*. Those published in the *Transactions* were, "Studies in the Nyssonine wasps: the species of *Psammaletes*,

a new sub-genus of *Hoplisoides*" (1936); "The generic names of sphecoid wasps" (1937); "Studies in the pemphredonine wasps: 1. New genera and species of the ammoplanoid complex" (1937); Three more parts of his "Studies in the nyssonine wasps" (1938); Two parts of "The taxonomy of the oxybeline wasps" (1940); "The generic names of the spider-wasps and their type-species" (1946); "The pemphilidine wasps of the Caribees" (1947); "A review of the genus *Moniaecera* (Pemphilidini)" (1948). Being a bachelor, Pate frequently returned to his parental home in Philadelphia and spent much time in study at the Academy of Natural Sciences so that, as in the case of the writer, the American Entomological Society may lay claim not only to having aroused an initial interest in wasps, but to having shared with Cornell a continued stimulus in his subsequent work.

We may now conclude by recording the other authors who have contributed papers on Hymenoptera to the *Transactions* during the last half-century. Since membership in the Society during the greater part of that period has not implied residence in Philadelphia, there would be no point in listing the members separately. There are thirty-one names in all and I shall mention them in chronological order, counting each from the date of his first contribution to the *Transactions*.

Sievert Allen Rohwer was born in Colorado in 1888, and became a pupil of Professor Cockerell at the University of Colorado where he graduated in 1909. That same year he published his only paper in the *Transactions:* "New Hymenoptera from the western United States", but he published between 1908 and 1934 about one hundred and ninety taxonomic papers on Hymenoptera in other sources. From 1909 until his death in 1951 he was employed in entomological work by the U. S. Department of Agriculture.

Henry James Franklin was born at Guilford, Vermont, in 1883, graduated at Massachusetts Agricultural College in 1903, and took his doctor's degree there in 1908. He worked on bumblebees under the surveillance of Professor H. T. Fernald, and in 1911 published in the *Transactions* a paper descriptive of new North American species. In 1912 and 1913 the *Transactions*

were largely given over to his voluminous monograph of the Bombidae of the New World, a very discriminating and high-grade piece of taxonomic work, indispensable up to the present day, which put knowledge of our bumblebees on a sound basis. Although employed throughout his life in economic entomology he maintained his early interest in these bees, and in 1954 published a final paper in the *Transactions:* "The evolution and distribution of American bumblebees". He died in 1959.

Alexander Arsène Girault was born in Annapolis, Maryland in 1884. He graduated at the Virginia Polytechnic Institute in 1903 and became interested in chalcid-flies. He was employed by the U. S. Bureau of Entomology in 1904, and subsequently in Illinois, and in Australia where he died in 1941. His taxonomic work was extremely erratic and confusing and the Society can claim little credit for having published in 1911 three papers on chalcid-flies.

Charles William Metz was born in Wyoming in 1889 and graduated at Pomona College in 1911, publishing in the *Transactions* in the same year "A revision of the genus *Prosopis* [now *Hylaeus*] in the United States". Although still professionally engaged in biology, he has shown no further interest in Hymenoptera.

Charles W. Hooker was born in 1881 and graduated at Amherst in 1906. He obtained his doctorate under Professor H. T. Fernald at Massachusetts Agricultural College in 1909, publishing a revision of the Ophionini in the *Transactions* of the Society in 1912. He died the following year. His only paper was a creditable piece of taxonomic work.

William Beutenmüller was born in Hoboken, New Jersey in 1864, and from 1888 until 1912 was Curator of Entomology in the American Museum of Natural History. Primarily a lepidopterist, he was also interested in Cynipidae on which he published a few papers; one, in 1913, in the *Transaction* of the Society, descriptive of new species. He died in 1934.

J. H. Merrill was a third student who worked under Professor H. T. Fernald in Amherst and wrote a single minor paper entitled "On some genera of the pimpline Ichneumonidae". It was published in the *Transactions* in 1915 and treated of four

genera and fourteen species, one of each new to science.

Clarence Eugene Mickle was born at Lincoln, Nebraska in 1892, graduated at the University of Nebraska in 1917, then took his doctor's degree at the University of Minnesota in 1925. He is at present Professor of Entomology at that institution, and a recognized authority on velvet-ants. In 1916, while a junior at college, he published his first paper in the *Transactions:* "New species of Hymenoptera of the superfamily Sphecoidea". This was followed twenty-four years later by "Descriptions and records of nearctic mutillid wasps of the genera *Myrmilloides* and *Pseudomethoca*".

J. C. Hutson published in 1919 "The North American species of the genus *Sceliphron*", a small but competent thesis done under Professor Fernald in Amherst. He has not carried on further work with Hymenoptera.

Theodore Henry Frison was born in Champaign, Ill., in 1895 and graduated at the University of Illinois in 1918, receiving his doctorate in 1923. In that year he published three papers in the *Transactions:* "New neotropical species of ensign-flies or Evaniidae", "Notes on the life-history, parasites and inquiline associates of *Anthrophora abrupta* Say", and "Systematic and biological notes on bumblebees". Frison thereupon seriously took up the study of bumblebees at the point where Franklin had left them, and especially contributed to our knowledge of the subgenera and the relations between North American and European forms. He published four more papers on the subject in the *Transactions;* one each in 1925, 1926, 1927, and 1929. He was director of the Illinois State Laboratory of Natural History, until the time of his death in 1945.

Joseph Charles Bequaert was born in Thourout, Belgium in 1886, and received his doctorate at the University of Ghent in 1908. Less than a decade later he came to America, was first employed on the staff of the American Museum of Natural History, later became Professor of Medical Entomology in the Harvard Medical School, and finally was appointed to one of the Agassiz professorships in Harvard University. Since his retirement from Harvard he has been teaching in Baylor University. His taxonomic work is most scholarly, and he is a recognized and

eminent authority on Vespidae. Beginning in 1925 he published in the *Transactions* "The genus Ancistromma in North America, with a partial key to the species", followed in 1939, 1940, and 1943 with three other taxonomic papers on Vespidae of South America and the Orient.

Harold Compère of the Experiment Station at Riverside, California, contributed in 1925 a single paper descriptive of a new genus and species of Chinese Aphelinidae.

Theodore Bertis Mitchell was born in Cambridge, Mass. in 1890, graduated at Clark University in 1920, and received his doctorate from Harvard in 1928. He is Professor of Entomology in North Carolina State College. He has long specialized on the genus *Megachile,* and has become the foremost student of the bees of the eastern United States. His first paper in the *Transactions* was on new species of *Megachile* and was published in 1926. This was followed in 1928 by a paper on sex anomalies in that genus, with descriptions of new species, and one in 1930 on neotropical *Megachile.* From 1933 until 1937 his weighty "Revision of the genus *Megachile*" appeared in the *Transactions* and was completed in eight parts. This is one of the most thoroughgoing and competent papers on a genus of American Hymenoptera that has been published. While Professor Mitchell had no close connection with the Society, it is clear that his monograph could not have been completed without detailed knowledge of the Cresson collection and comparison with its types.

S. I. Salman, another student at the Massachusetts State College of Agriculture, contributed a paper to the *Transactions* in 1929 but has not pursued further work on wasps. It was a study of the morphology of a species of *Pepsis.*

Harry Willis Allen, currently President of the Society, acquired his connection with it long after he became an entomologist. He was born in Pelham, Mass. in 1892, graduated from Massachusetts State College of Agriculture in 1913, took a Master's Degree at Mississippi State College in 1922, and received his doctorate from Ohio State University in 1926. As a government entomologist he has long been stationed at Riverside, New Jersey, where the work on discovering parasites suitable to the control of the Japanese beetle led him into taxonomic studies on

Tiphia. He wrote two papers on those wasps that appeared in the *Transactions;* one in 1934, the other during the following year.

Donald Timmerman Ries was born in Ithaca, New York in 1903, graduated at Cornell in 1925, and took his doctor's degree there in 1930. The writer interested him in the study of Cephidae, and seven years later he published his only contribution to the *Transactions*, "A revision of the nearctic Cephidae". He is a teacher of biology at the Illinois State Normal University.

H. Pearson Hopper published a descriptive paper on Ichneumonidae in the *Transactions* in 1938. This was followed the next year by a synoptic revision of the tribe Trogini of the United States and Canada, which has proven a valuable paper. Hopper's work was based on the collection of the Society.

Karl Von Vorse Krombein was born in Buffalo, New York in 1912. He graduated at Cornell University in 1934 and received the degree of Master of Arts in 1935. His thesis, published in the *Transactions* in 1938, was a revision of nearctic Myzininae. This was followed in 1939 by a revision of the Myrmosidae of the New World, in 1952 by a list of the wasps of Westmoreland State Park in Virginia, in 1954 by a taxonomic paper on Florida wasps, in 1956 by a generic revision of Amiseginae (cuckoo-wasps), and last year by a paper on the biology and taxonomy of cuckoo-wasps of coastal North Carolina. Krombein is an employe of the U. S. Department of Agriculture assigned to the taxonomic study of wasps in the U. S. National Museum. His papers are of high grade and involve much work done on the collections of the Society of which he has been a member since 1936.

William G. Bodenstein published a paper in the *Transactions* in 1929 on type-species of the genera of cuckoo-wasps, a family in which he developed an interest while a student at Cornell University.

Earle Gorton Linsley was born in Oakland, California in 1910. As a student at the University of California where he graduated in 1932, received his doctorate in 1938, and is now Chairman of the Department of Entomology, he became interested in bees.

In 1939, jointly with C. D. Michener, he published in the *Transactions* a revision of the North American Nomadidae. In 1940 and 1943 he published four more revisions of genera of that family.

Charles Duncan Michener was born in Pasadena, Calif. in 1918. He graduated at the University of California in 1939 and published in that year in the *Transactions* jointly with Dr. Linsley the paper referred to above, and a revision of a genus of Nomadidae, *Neolarra*. He received his doctorate at Berkeley in 1946 and is now chairman of the Department of Entomology at the University of Kansas.

Laurence Goddard Wesson, Jr. was born in Midland, Michigan in 1917. He graduated at Haverford College in 1938, and the next year published in the *Transactions* a study of the biology of *Harpagoxenus*, a genus of ants. Since 1953 he has been an associate professor in New York University.

Herbert Holdsworth Ross was born in Leeds, England in 1908, and graduated at the University of British Columbia in 1927. He received his doctorate at the University of Illinois where he is now an assistant professor and is also systematic Entomologist in the State Natural History Survey. As a former pupil of the late Dr. A. D. MacGillivray he acquired an interest in sawflies on which he has published important papers and is, in fact, the leading North American authority. His work has required familiarity with the Norton and Cresson collections. He has published only one paper in the *Transactions*, in 1943: "The North American sawflies of the genus *Hoplocampa*".

Henry Keith Townes, Jr. was born in Greenville, South Carolina in 1913. He graduated at Furman College in 1933 and received his doctorate at Cornell University in 1937. He came to Cornell as a dedicated entomologist and began his life-long work on Ichneumonidae. In 1940–41 a National Research Fellowship allowed him to spend a year of research on these insects, principally in Philadelphia, studying the Society's collection. There resulted his voluminous "Catalogue and reclassification of the nearctic Ichneumonidae", published in 1944 as a *Memoir* of the Society. This brought the pioneer work of Cresson to a measure of fruition and brought order out of the chaotic state then exist-

ing in the taxonomy of that difficult family. Its publication may be regarded as one of the greatest achievements of the Society in setting the knowledge of Hymenoptera on a sound basis. Dr. Townes is currently carrying on his research in the Ichneumonidae at the University of Michigan as holder of a special fellowship.

William Louis Brown, Jr. was born in Philadelphia in 1922. He graduated at Pennsylvania State College in 1947 and received his doctorate from Harvard in 1950 where he is a curator of insects in the Museum of Comparative Zoology. He was elected a member of the American Entomological Society in 1939, and in 1948, 1949, and 1950 published seven papers on the taxonomy of ants in the *Transactions*. These have been principally revisionary papers on Dacetini of the world, but have included an important paper on the wing-venation and phylogeny of ants.

Lewis Judson Stannard, Jr. was also born in Philadelphia, but in 1918, and also graduated at the Pennsylvania State College. He received his doctorate from the University of Illinois in 1952, and three years earlier published a revision of the nearctic species of the sawfly genus *Periclista* in the *Transactions*. He is now on the staff of the Illinois State Natural History Survey where his research work is on Thysanoptera.

Howard Ensign Evans was born in East Hartford, Connecticut in 1919. He graduated at the University of Connecticut in 1940 and received his doctorate from Cornell University in 1949. While a student at Cornell he began research on the Pompilidae, publishing in the *Transactions* in 1950 and 1951, in three parts, "A taxonomic study of the nearctic spider-wasps belonging to the tribe Pompilini". During 1955, 1956, 1957, and 1958 he has published, in four parts, "Studies on the larvae of digger-wasps", two of these conjointly with one of his students, Cheng Shan Lin. This is the first extended comparative study of the larvae of aculeate Hymenoptera that has been made anywhere. Dr. Evans is now Professor of Systematic Entomology in Cornell University.

Cheng Shan Lin was born in China. He received his doctorate from Cornell University and is now teaching biology at Huston-Tillotson College in Austin, Texas. In 1955 and 1956 he published jointly with Professor Evans two of the papers on larvae

of Hymenoptera referred to in the preceding paragraph.

Kenneth Willard Cooper was born in Flushing, Long Island in 1912. Graduating at Columbia University, he taught at Princeton from 1939 to 1953 and has since been head of the Department of Biology at the University of Rochester. His biological interests have been wide. In 1952 he published in the *Transactions* a paper descriptive of a new genus of cuckoo-wasps. The following year he published one on the "Ecology, predation and competition of *Ancistrocerus antilope* (Panzer)", and finally, in 1955, the results of a study of the remarkable relationship between a certain mite and the wasp *Ancistrocerus antilope*. Probably the Society contributed in no way directly to these studies.

Louis Marcus Roth, born in New York City in 1918, and Edwin Roy Willis, born there in 1911, both of whom received their doctorates from Ohio State University in 1947, published jointly a paper in the *Transactions* in 1954 on a chalcid parasite of the eggs of a cockroach. They are each in a research division of the armed forces of the United States but have given no further indication of interest in Hymenoptera.

The reason for including biographical detail in this paper has been to show who these people were and what sort of men have been stimulated or encouraged by their associations with the Society to become hymenopterists, or, having started their work elsewhere, have been supported by finding in the *Transactions* of the Society an available source of publication. Few of the hymenopterists of North America have not been included.

Speaking metaphorically, we may say that Thomas Say sowed the seed, that Cresson and his confreres tended it into a sturdy tree, and that in the last half century it has blossomed wonderfully on many branches. Surely those fifteen enthusiastic amateurs who met together on February 22nd, 1959 to form the Entomological Society of Philadelphia would be well content if they were alive to read this account of what their foresight has led to as concerns this one order, and by the time they had finished the sister papers on other orders, they should be very happy indeed.

THE DEVELOPMENT OF AMERICAN DIPTEROLOGY

BY CHARLES P. ALEXANDER
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In conjunction with the celebration of the centenary of the founding of the American Entomological Society it has been suggested that I provide a brief account of the leading events of the past century insofar as they concern the development of our knowledge of the Diptera. In order to add to the value of such an account it seems worth while also to consider the progress in our knowledge of this subject during the preceding century, that is, since the date of the appearance of Linnaeus' "*Systema Naturæ*," Edition 10, 1758. From this account it will be seen that virtually all of our knowledge of the Diptera of North America dates from the beginning of the 19th Century and, in greatest part, from 1858, the approximate time of arrival in America of Baron Charles Robert v.d. Osten Sacken, most appropriately considered as being the "Father of American Dipterology." The coincidence of this date with the founding of the American Entomological Society is noteworthy and significant.

1758–1858

The binomial system of nomenclature, as it concerns Zoology, dates from the appearance of the 10th edition of the *Systema Naturæ*, of Carl Linnaeus (Carl von Linné), arbitrarily considered as having been published January 1, 1758. In this pioneer work Linnaeus recognized only ten genera in the Diptera, with a total of 188 species, of which 16 were from various parts of the Americas, the specimens having been collected by former students of Linnaeus. Such include Loefling and Rolander in South and Middle America, and Peter Kalm in eastern North America, the last providing a total of six of the named species but including only the most common and familiar types, such as *Culex pipiens, Calliphora vomitoria*, and *Musca domestica*. All

of the New World species of Diptera then described by Linnaeus were placed by him in three genera,—*Culex, Tabanus,* and *Musca.* Later a further species, *Asilus aestuans* Linnaeus, was added to this record. The inclusion in the 10th edition of the *Systema* of *Hippobosca equina* as being American must be seriously questioned.

The outstanding pupil of Linnaeus who pursued the study of insects was Johann Christian Fabricius (1745–1808), justly considered as being the "Father of Entomology." Fabricius, between 1775 and 1805, described a considerable number of Diptera, these including many North American forms with several of our best-known eastern species. Students on extra-European flies during the first half of the 19th century included an outstanding American, Thomas Say, whose work will be considered in more detail later, and a number of Europeans who made a beginning in the study and naming of the great mass of specimens that were beginning to filter into the leading museums and collections from abroad. Such workers included particularly Pierre Justin Marie Macquart (work on Diptera, 1834–1855), Francis Walker (1848–1871), John Obadiah Westwood (1833–1876), and Christian Rudolph Wilhelm Wiedemann (1821–1831).

The systematic studies of Thomas Say (born 1787, died 1834) included a great range of natural history objects, with special attention being devoted to insects and molluscs. It is because of his pioneer work on the eastern North American insects that Say is generally regarded as being the "Father of American Entomology." Among the very considerable number of new insects discovered and described by Say were several Diptera, including some of our best-known species. The destruction of the Say collection in the period between July 1836 and January 1842 has been described at various times in the past and need not be repeated here. It is sufficient to state that all of his Diptera were destroyed, including the types or virtual types of the many species. It may be noted, however, that some time before he left Philadelphia to take part in the New Harmony movement he had made an exchange of specimens with Wiedemann in Vienna and, as a result, a certain number of his species of Diptera are still preserved in the Vienna Museum and may well have first

claim to being considered as representing neotypes of the various Say species. As concerns the Tipulidae, which I have seen, it may be indicated that all such specimens are pinned with a steel needle (with an eye) instead of with a pin in the manner with which we are now familiar. It seems probable that all such Diptera of the Say collection may have been preserved in this manner.

1858–1958

With the foregoing brief account we may now consider the work of the past one hundred years in which the American Entomological Society played such an important part. During the previous century, in the already considerable descriptive work on insects, the Diptera had been much neglected, particular attention having been devoted to the more striking or showy insect orders, as the Lepidoptera and Coleoptera. This neglect of the study of the Diptera was to be remedied suddenly and dramatically by the efforts and interests of a single man, Baron Osten Sacken, whose work and achievements with the order in America merits special consideration.

Osten Sacken was born in St. Petersburg (Leningrad), Russia, on August 21, 1828, and when only ten years of age became interested in insects, at first in the Coleoptera but very shortly turning his full attention to the Diptera. In his youth and early manhood he had been trained for work in foreign diplomatic service and in 1856, at the age of 28, was appointed to active duty in America as Secretary of the Russian Legation in Washington, a position that he held until 1862. At that time he was made Russian Consul General in New York, conducting this important office until 1871 when he resigned the position to become a private citizen. He remained in the United States until 1877, making various trips to Europe and one (1876) to California, giving a total of 21 years of service in this country. He returned to Europe where he resided for the remainder of his life (died May 20, 1906, in Heidelburg).

Following his arrival in New York City in June 1856, Osten Sacken made detailed plans to undertake a critical study of the Diptera of this country. His first step was to prepare a pre-

liminary catalogue of the species hitherto described in order to provide a firm basis for the detailed work to follow. This first Osten Sacken catalogue [1] included some 1800 species, or names, the great majority of which proved to be quite unrecognizable from the insufficient early descriptions or, in many cases, synonyms of previously described species. With knowledge of the work that had been done in the past Osten Sacken was ready to proceed rapidly. He determined that a great basic collection of American Diptera would be formed and that this should finally be deposited in some leading American institution, in the final choice this being the Museum of Comparative Zoology at Cambridge, Massachusetts. This early decision to form a major collection of flies for America is somewhat reminiscent of the youthful Coleopterist, John Lawrence Leconte, who in 1844, at the age of 19, delivered his so-called "Declaration of Independence" from the European students who to that date had described most of the American beetles.

Realizing as he did that it would be impossible for himself alone to handle the evidently considerable number of species in the Diptera, Osten Sacken enlisted the help of the outstanding taxonomic student of the order in Europe, Dr. Hermann Loew (1807–1879), to collaborate in this ambitious project. Before Osten Sacken's opportunity to come to America Loew had shown only a mild interest in him, but now fell readily into the proposal as it gradually unfolded. Osten Sacken himself handled only limited groups within the order, particularly the limoniine Tipulidae and the Tabanidae, and turned over to Loew, for description, large series of specimens in most other groups in the Diptera. This cooperation was extended not only to supplying Loew with specimens of flies for study and naming, but included also the major work of translating from the original German manuscript the three volumes by Loew included in the four-volume set of the "Monographs of North American Diptera," as well as the final editing and proof reading of these volumes as they were prepared for final publication. The fourth volume of this outstanding work, and the only one prepared by Osten

[1] Osten Sacken, C. R. Catalogue of the described Diptera of North America. Smithsonian Miscell. Collections, 3: pp. xx + 192; 1858.

Sacken himself, was on the limoniine Tipulidae (1869). The greatest proportion of American Diptera described by Loew were in his ten so-called "Centuries of North American Diptera," one thousand species being described in ten parts of one hundred species each (Century *1*, 1861; *10*, 1872). In all, Loew described some 1350 species of North American Diptera, the great proportion of which had been sent to him by Osten Sacken, being based either on his own personal collections or on materials sent by collaborators for this specific purpose. The Loew collection of North American Diptera was packed by Osten Sacken in Guben, Germany, in 1877 and safely transported to Cambridge where it was added to the smaller but almost equally valuable Osten Sacken collection, making a total of more than 2000 North American Diptera, virtually all represented by type material or by authentically named specimens. This remains the most valuable single collection of North American Diptera. The account of Osten Sacken's relations with Loew, and with many other leading Dipterologists of his time, has been detailed in full in an increasingly rare autobiographical work of Osten Sacken.[2]

Osten Sacken concluded his more than twenty years work on the Diptera of North America by the preparation and publication of his second Catalogue, published in 1878,[3] which included in excess of 2500 species of North American Diptera, the great majority of which are valid and almost all represented in the Loew-Osten Sacken collection in Cambridge. When completing this work, and terminating his stay in America, Osten Sacken expressed the belief that it seemed certain to him that the number of North American species of Diptera would eventually equal or exceed the number of Coleoptera in the same area. He further indicated that in his opinion the study of the Diptera required a more detailed and thorough examination than is true in most orders of insects. He stated: "Each family of Diptera requires a special study and a dipterologist may be very well versed in some families without being able to express any opinion with

[2] Osten Sacken, C. R. Record of my life work in Entomology. Pp. viii + 242, 3 plates; three parts: first and second, Cambridge, Massachusetts, October 1903; third, Heidelberg, Germany, 1904.

[3] Osten Sacken, C. R. Catalogue of the described Diptera of North America. Smithsonian Miscell. Collections, 270: pp. 48 + 276; 1878.

regard to questions concerning others, *Specialization* is therefore the motto of dipterology." The soundness of the above observation is shown by the fact that virtually all later, and especially more recent, students of the order have restricted their efforts to a single family of flies or, at least, have specialized closely within the order.

THE PUBLICATIONS OF THE AMERICAN ENTOMOLOGICAL SOCIETY

The predecessor of the American Entomological Society, the Entomological Society of Philadelphia, was officially founded on March 1, 1859 and soon began publication of the *Proceedings* of the Entomological Society of Philadelphia, volume 1, number 1, being dated March-May 1861. Between this date and March 1867 six volumes of the *Proceedings* appeared, including a total of eight papers that concerned the Diptera, five of which were by Osten Sacken, two by Walsh on the gall-making Cecidomyidae, and a single one by Grote on the Bombyliidae, the sole paper in this order by the distinguished Lepidopterist.

Difficulties in the publication of this journal and the manner in which they were met and overcome have been described in a most interesting account by Osten Sacken that is quoted in full herewith.

V. A CONTRIBUTION TO THE HISTORY OF THE ENTOMOLOGICAL SOCIETY OF PHILADELPHIA.

Residing, as I did, in Washington (up to 1862), I had the opportunity of witnessing the origin and the first beginnings of the Society. To me, a European, these beginnings afforded such a remarkable insight into American energy and enterprise that I am glad to give a short account of them.

There was no entomological society in existence in the United States in 1861. A number of friends of entomology in Philadelphia started the idea of forming such an association, and this undertaking soon found a sympathetic response from other parts of the country. Numerous written communications, donations, and specimens began to flow in after the first meeting of the new association on the 11th of March, 1861. The Proceedings of the Society, Vol. I, p. 2–6, contain the account of our first four meetings. The want of funds which impeded at first the progress of the Society was relieved by Dr. Thomas B. Wilson, "one of the earliest and most devoted members" who, "from the very commencement of this Society," gave it a "firm and unwavering support, by contributing to its Library and Cabinet, and by large endowments in money" (Proc., Vol. IV, p. vii, 1865). Dr.

Wilson, unfortunately for the Society, died four years after its foundation. The most active member of the Society, however, was its Corresponding Secretary, Mr. Ezra T. Cresson, with whom I kept up at that time an active correspondence. I shall content myself with reproducing passages of his letters, which speak for themselves.

On September 4, 1861, Mr. Cresson wrote: "We do our own printing, as you already know; I am the compositor and also assist in the press-work, and although I have had little or no experience in setting type (I have set the type for *all* the pages of the *Proceedings* thus far), yet be assured that I will do my best to have your paper got up in as neat and scientific a style as possible, although we have but three kinds of type, *Long Primer, Minion,* and *Minion Clarendon.*—The next number will appear at the regular time, unless something unforeseen should happen."

September 26, 1861: "Please excuse me for troubling you with a proof *of one single page only;* the reason I send this single page is this. On Monday evening last Dr. Wilson, with his usual liberality, presented the Publication Committee with enough money to purchase a press which will print four pages at once. We now have the press at the room, ready for action, and now as we have sent you the proof of the first *three* pages (which by the way LeConte has returned corrected) we send the enclosed to make up the fourth, so that we may go on and print them off, as soon as you return this one corrected. By the time this is corrected and returned, *four more* pages will be on their way to you for correction, and so on until the paper is finished. So please return the enclosed as soon as you possibly can. The 25 copies *extra* will, with much pleasure, be forwarded to you as soon as the paper is finished.—If you should have any paper hereafter that may require lithographic plates (such as larvae, etc.), we will bear the expenses of getting them up and printed off, that is if the drawings are sent to us. We have a young artist, a member, who has undertaken to do all the lithographing for us free of cost; all we have to pay for is the press-work and paper.—Now as we have a large press, we are ready for any amount of material!"

The *large press* enabled the Publication Committee to print four pages at once; and yet, the small hand-press, with the type set by Mr. Cresson, from which the single pages of the first issues of the *Proceedings* were struck off, produced work which can stand comparison with the best work of an average typography.

November 12, 1861: "Please find herewith 25 extra-copies of your valuable paper. I hope that you will excuse any errors that may be found, and also if the general appearance may not be so uniform as books generally are, but please remember that we are not printers by trade, but only greenhorns, and have to learn everything by experience. We hope to improve as we progress. We never dampen our printing paper, because it removes the glossy whiteness. We use the best ink and paper, we only want experience to make a *tip-top* job of it. By doing the printing ourselves we save a great deal. For instance, our first number cost us only

about $11; the second, $8.50; and the third, $10.—Total, only $29.50, say $30, for a pamphlet of 72 pages and 250 copies! We have already saved nearly $80 by working the affair ourselves.—We have plenty of material for No. 4 (November and December, 1861), but we have none for No. 5 (January and February, 1862). Can you give us something for this number?—I hope that we will receive the earnest encouragement and co-operation of all entomological authors, for our Journal can hardly fail to be a valuable medium through which to diffuse entomological science."

I have before me *seventy-two* letters of this kind, in the neatest handwriting, which I received from Mr. Cresson between 1861 and 1869; twenty-one of them were written during the year 1862 alone. I was delighted to have my papers published by the Society, for, so far as my knowledge of typography goes, I could not have found elsewhere in the United States a special periodical with such a *"tip-top"* printing as theirs (besides my natural desire to encourage such exemplary scientific zeal). For the first volume (between October, 1861, and February, 1863) I furnished *five* papers, occupying nearly one hundred pages of the volume. Among them are my papers on the larvae of *Mycetophilidae* and on those of some rare *Coleoptera,* both accompanied with plates. My series of papers on *Cynipidae* and several other papers appeared in the same *Proceedings.*

I am glad to have found this opportunity for inserting in my "Record" an expression of my gratitude and appreciation to Mr. Cresson and his associates at that time![4]

At a meeting of the Society on February 11, 1867, under the presidency of George H. Horn, and on the motion of Augustus R. Grote, it was voted that the name be changed to The American Entomological Society. At the March 11th meeting, with Horn again presiding, the name of the society was officially changed from its former title to The American Entomological Society, as of February 23, 1867. The title of the official publication of the new society likewise was changed to the *Transactions of the American Entomological Society,* the first volume appearing in 1867–1868. Publication of this highly important journal has proceeded without interruption because of wars or financial crises until the present date (volume 85, 1959), and in this long period has included papers by a considerable majority of workers on systematic entomology in America in addition to fewer papers on other branches of the science.

The early volumes of the *Transactions* were concerned in large part with papers on the more popular orders of that time, espe-

[4] Osten Sacken, C. R. Record of my life work in Entomology. (Reference pp. 41–43.)

cially the Coleoptera (Crotch, Leconte, and Horn; Smith in 1882); Lepidoptera (Edwards and Grote; C. H. Fernald and Lord Walsingham in 1882); and the Hymenoptera (the elder Cresson, McCook; Ashmead in 1881). The chief contributor of papers on the Diptera was the younger Cresson, with important studies on the Pipunculidae and the acalypterate Muscoidea. In later volumes the majority of the papers concern the Orthoptera, including particularly the outstanding work of Rehn and Hebard. The relative lack of interest in the Diptera in the early years of the Society is indicated by the fact that in the first fifteen years of publication of the *Transactions* (1867–1882) there were only five papers on this order, four being by Osten Sacken. In the entire series of volumes, only 127 papers on the Diptera are included and I have provided a summary, by decades of publication, indicating the number of papers in this order. As a matter of further interest I have listed the various authors and the date of their first paper. It should be emphasized that such a date is not necessarily the first published paper of the author in question.

TRANSACTIONS OF THE ENTOMOLOGICAL SOCIETY

Vols. 1 (1867) to 83 (1957)		Numbers of Papers on Diptera
1867–1883	Vols. 1–10	5
1884–1893	11–20	18
1894–1904	21–30	13
1905–1914	31–40	14
1915–1925	41–50	25
1926–1934	51–60	21
1935–1944	61–70	17
1945–1957	71–83	14

First paper by

* Schimer, Henry	1867	Davidson, W. M.	1923
* Osten Sacken, C. R.	1868	* Van Duzee, M. C.	1923
* Williston, S. W.	1883	* Bezzi, Mario	1924
* Coquillett, D. W.	1887	Curran, C. H.	1924
* Smith, J. B.	1890	Landis, E. M.	1924
* Townsend, C. H. T.	1891	Painter, R. H.	1926
* Johnson, C. W.	1895	Allen, H. W.	1927
* Aldrich, J. M.	1896	* Bromley, S. W.	1927
* Hunter, W. D.	1899	Brown, C. J. D.	1928
Melander, A. L.	1902	Hull, F. M.	1930
* Brues, C. T.	1903	Leonard, M. D.	1931
* Cresson, Jr., E. T.	1906	Huckett, H. C.	1934
Haseman, Leonard	1907	Sabrosky, C. W.	1935
Jones, P. R.	1907	James, M. T.	1936
* Cockerell, T. D. A.	1908	Fisher, E. G.	1938
Back, E. A.	1909	Dalmat, H. T.	1942
Alexander, C. P.	1914	Rapp, Jr., W. F.	1945
* Dietz, W. G.	1914	Knight, K. L.	1946
Malloch, J. R.	1914	Laffoon, J. L.	1946
Johannsen, O. A.	1916	Shaw, F. R.	1952
* Hine, J. S.	1917	Sturtevant, A. H.	1953
* Marchand, Werner	1918	Wheeler, M. R.	1954
Cole, F. R.	1919	Greene, C. T.	1955
* Crampton, G. C.	1923		

* Deceased.

Entomological News.—As stated by Mr. Aaron in the initial issue of the *News*, this was not intended primarily for descriptive and technical reports on entomology, such being handled better in the *Transactions* or in publications of other organizations. It was planned more especially for shorter papers on insects, of a general nature, including also miscellaneous news items and so-called entomological "gossip." The new publication was sponsored by the entomological section of the Academy of Natural Sciences of Philadelphia in cooperation with the American Entomological Society. Volume 1, no. 1 of the *News* appeared in January 1890, when I was only four months old! Twenty years later, in 1910, my initial paper on the Tipulidae appeared in the

News, the first of more than 700 on the same general subject.

An examination of the various volumes of the *News,* totalling 70 volumes through 1959, shows a considerable increase in the proportion of papers on the Diptera in relation to other orders of insects and thus reflects a marked and growing concern in the two-winged flies. To indicate this increased interest and appreciation of the new journal, the list of contributors of dipterological papers in its first decade include the following distinguished workers: Cockerell, Coquillett, Hough, Johnson, Kincaid, Townsend, Wheeler, and Williston.

Memoirs of the American Entomological Society.—The youngest of the three publications sponsored wholly or in part by the Society is the *Memoirs,* of which Number 1 appeared in 1916, the latest, No. 16, in 1959. Three of these *Memoirs* include very important papers on the Diptera: No. 7, by Leonard, on the North American Rhagionidae (Leptidae); No. 10, by Huckett, on American Muscoidean flies of the genus *Pegomyia;* and No. 12, by Phillips, on the biology and identification of the larvae in the Trypetidae.

In concluding this brief review of the Diptera and the profound influence that the American Entomological Society has had on its study and appreciation over the past century, I would like to add a few further personal remarks as was suggested by the chairman. My first visit to Philadelphia and the Academy was in 1914 and provided the opportunity of meeting the leading entomologists in residence at that time. I shall always remember with deepest appreciation the kindly treatment and consideration extended to a young student, by all, but particularly by Mr. Rehn and the younger Cresson whose personal interest and friendliness meant so much to me at that time and later. I wish to add my heartfelt best wishes to those of a host of other friends and workers for a further long period of success and progress in the work of the Society. It is hoped and expected that the fullest help and cooperation may be extended by all throughout the second century of the Society's existence.

THE EARLY HISTORY OF SAWFLY STUDY IN NORTH AMERICA

BY HERBERT H. ROSS

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Sawflies are represented in the world by an estimated 8,000 or 10,000 known species which are at present grouped in more than a dozen families. Many sawflies are large and colorful, others are small and drab and offer little in the way of obvious external characters. In these latter groups minute characters of tarsal claws, sutures of the body, structure of mouth-parts, and detailed characters of the female ovipositors and the male genitalia must be used for accurate diagnosis. Larvae of sawflies are chiefly caterpillar-like and many of these present few conspicuous differences to aid in their identification. Even so, associated larvae are necessary for the accurate identification of species in at least a few sawfly genera or species complexes.

Because of the necessity of studying many minute characters, the current sawfly worker deals as often with prepared slide mounts as with the whole specimens, and needs excellent microscopic equipment to supplement the museum facilities for the preparation and housing of material.

Against this background of somewhat highly specialized techniques, it is interesting to look back on the steps in the early part of the 19th century which led to our first knowledge of these insects in North America. At that time hand lenses were the standard optical equipment for the examination of specimens. It should be noted, however, that some of these old hand lenses gave magnifications up to 30 or 40 diameters and when manipulated by experts could be used for seeing an astonishing amount of detail.

The first North American naturalists who studied sawflies had only a few identification aids in the literature at their disposal. Some of the papers by Linnaeus, Réaumur, and DeGeer con-

tained descriptions of a few North American species and the works of Réaumur in particular illustrated many adults and larvae of the European fauna. These works were of more than ordinary help for the North American worker because a relatively large number of abundant genera are common to both Europe and North America.

The starting point for the serious student was the *Systema Piezatorum* published by Fabricius in 1804. Fabricius was the first specialist in the order Hymenoptera, or the Piezata as he called them. In this 439 page treatise, pages 15 to 53 contained a complete list with descriptions of the sawflies known for the world. The sawflies were not designated as any particular subdivision of the Hymenoptera but in the book simply constituted the first eight genera: *Cimbex, Tarpa, Hylotoma, Tenthredo, Lyda, Oryssus, Sirex,* and *Xiphydria.* The number of sawfly species totaled 141 for the world and six for North America. Because of historical interest these North American species treated by Fabricius are listed below, together with the information which accompanied them concerning biogeographic distribution.

" *Hylotoma coccinea*	Habitat in Carolina
Hylotoma clavicornis	Habitat in America septentrionali
Lyda amplecta	Habitat in Carolina
Sirex columba	Habitat in America borealis
Sirex nigricornis	Habitat in America septentrionali
Sirex flavicornis	Habitat in Labrador Americae "

Two other species, *Sirex cyaneus* and *Sirex albicornis,* listed as South American were in reality North American. The error appears to have been corrected in the early work of American authors.

A few species such as the pear slug were listed without any locality but with reference to specific host, as follows:

" *Tenthredo cerasi*	Habitat in *Cerasi foliis* "

Compared with our present library of illustrated keys and detailed lists, this list and its brief descriptions certainly gave little aid to the early student of sawflies in this country. The fact that these early students persisted as they did shows that they were

motivated far more with the enthusiasm of exploring a new fauna than with worries about deficiencies in the literature.

Following Fabricius, more useful and in some cases more detailed diagnoses of genera and species were published by Latreille and Klug. Klug in particular described a large number of South American sawflies plus a few from North America. His descriptions were unusually succinct and detailed for his day, well deserving the same reputation for fine discrimination which Say later earned. Leach, in his *Zoological Miscellany* (1814–1817), described a few more North American species, chiefly forms collected by Abbott in Georgia.

In 1823 the first sawfly specialist made his appearance in the field; LePeletier published his *Monographia Tenthredinetarum*. This very useful book listed and described the 419 species then known for the world. A few of these were new species described from North America.

Immediately after this, sawflies were studied and described in a taxonomic fashion by an American author, Thomas Say. A few species were recorded in his *American Entomology*, but the greater number of his species were described in the report on Long's Expedition and in papers in the *Boston Journal of Entomology History*. It is perhaps prophetic of later developments in sawfly activity that Say was associated with the Academy of Natural Sciences of Philadelphia.

After Say's work there was nearly a 20-year lull in sawfly studies by American authors but not by those in Europe. In 1837 an astonishing book, *Die Familien der Blattwespen und Holzwespen*, came from the pen of Theodor Hartig, a forest entomologist in Germany. Hartig prepared the first true keys, outlined the first group classification for the sawflies, gave a large amount of exceedingly detailed and well illustrated material on the morphology of typical members throughout the group, and stressed the larvae and their biologies. The descriptions, primarily for species of the German fauna, are detailed and his descriptions of generic characters for both larvae and adults are exhaustive. This was truly the start of modern sawfly taxonomy.

In the next few decades only a scattering of North American sawflies were described, most of them by such well-known ento-

mologists at T. W. Harris, Asa Fitch, and B. D. Walsh. A high proportion of these species were reared and the life history described. In their writings these authors drew attention to several of the European species which had been brought into this country accidentally with cultivated plants. Concurrently, two specialists in the Hymenoptera began studies involving the sawflies, Edward Norton and E. T. Cresson. In 1861 Cresson published a list of the sawflies inhabiting North America and, in a list of the order for the Colorado Territory published in 1863, described six new species. Aside from these two contributions, Cresson devoted himself to other groups of Hymenoptera until Norton was no longer active in the group.

Norton published his first sawfly paper in 1860 in the *Boston Journal of Natural History*, contributing four more papers in this *Journal* up to 1862. From this time onward his entire publications on the sawflies were published in the *Proceedings* of the then new Entomological Society of Philadelphia and later in the *Transactions of the American Entomological Society*.

Of the ten sawfly papers published by Norton, the outstanding contribution was the *Catalogue of the Described Tenthredinidae and Uroceridae of North America*, which appeared during 1867–1869 as four installments in the first two volumes of the *Transactions of the American Entomological Society*.

In this young Society there must have been a tremendously enthusiastic spirit for obtaining an understanding of the vast number of unknown species of insects which inhabited the North American continent. Practically all the major orders had devotées in this band of ardent naturalists who included lepidopterists, coleopterists, hymenopterists, and others. Many of this group, including Norton and Cresson, were businessmen, and this probably explains how they were able to raise sufficient funds to publish the long, comprehensive papers which they did. Together this fraternity of pioneers opened up vast entomological horizons.

Norton's *Catalogue* was a worthy member of this group of comprehensive papers. It contained keys to the families and genera and to the species in many of the larger genera such as *Selandria*, *Nematus*, *Macrophya*, and *Tenthredo*. Even today

some of these keys of Norton's are the only ones we possess for the species of the entire continent. The species descriptions were unusually clear. Altogether about 300 species were treated in this publication which Norton modestly warned was only a "synopsis." If Hartig is regarded as the father of sawfly classification then Norton is certainly the father of North American sawfly studies.

After the *Catalogue* and probably because of it, interest in North American sawflies increased greatly although Norton himself published only one other paper on them. In the 1870's Cresson received a large amount of Texas material from Gustaf W. Belfrage, the Swedish naturalist of Norse, Texas, plus a large amount of western material from Nevada collected by Morrison. Primarily from this material Cresson in 1880 described another large group of North American sawflies and published another list of the species known from North America.

Meanwhile the Abbé Provancher had become interested in the Hymenoptera of Canada and published a long series of papers in the *Naturaliste Canadiene* between the years 1873 and 1882. Together these papers contained a fine resume of the sawflies of Canada. Provancher also described a large number of new species and provided a working basis for the recognition of the Canadian sawfly fauna highly satisfactory for that day.

During this period entomologists at the British Museum had been engaged in a most useful project, a listing of the specimens in their institution. The volume treating the sawflies was written by W. F. Kirby and appeared in 1882. In addition to listing the species in the British Museum, all the described species for the world were mentioned. The British Museum had acquired an unusually large number of sawflies collected by Dr. Barnston at St. Martin's Falls, Albany River, south of James Bay, Ontario, and from this material in particular Kirby described a large number of new species. The most important feature of this book was its colored illustrations. It contained sixteen plates and altogether illustrated nearly 250 species in color. This was and still is an extremely useful piece of work.

The climax of this early phase of sawfly work was the *Synopsis of the Hymenoptera* by Cresson which was published in

1887. This contained keys to the families and genera and a catalogue of the described species from America north of Mexico. Cresson listed 575 valid species, a far cry from the six listed in Fabricius' *Systema Piezatorum* at the beginning of that century.

In a very real sense Cresson's *Synopsis* marks the end of the early period of work on North American sawflies. Immediately following its publication little work was done on the North American fauna, but a decade later an entirely new crop of specialists was beginning to dominate the field, Konow and W. H. Morice in Europe, W. H. Ashmead and H. G. Dyar to some extent, and then principally S. A. Rohwer and A. D. McGillivray in North America.

These later North American workers relied heavily, as I have done in my own sawfly work, on the remarkably sound foundations laid by these earlier workers, especially Norton and Cresson. These two pioneers stand out along with many of their other colleagues in the early days of the American Entomological Society as resolute leaders where leadership was needed. The entire entomological fraternity owes them a great vote of thanks for the long hours which they devoted to their studies of insects. Some would remind you that these hours were "without pay" but it is my own firm belief that the high sense of accomplishment and adventure enjoyed by these pioneers repaid them for their efforts to a degree that we might not ourselves be able to appreciate. After all, we think of them now as "old masters," but at that time they did not feel old; quite to the contrary, they were probably young in spirit as long as they were looking at insects.

One more thought needs to be expressed in this chapter of early events. The entomological profession owes a great debt also to the continuing staff of the American Entomological Society, both for the excellent care which they have given to the priceless collections assembled by the early pioneers and for keeping available copies of the printed papers of many of the early works. The availability of both the types and the published papers has been of the greatest assistance to all later workers in the sawflies and I am sure this is true for many other groups.

On this Centennial of the American Entomological Society, therefore, not only do the names of Norton and Cresson stand out as signal figures representing the field of sawfly taxonomy, but the Society itself deserves the greatest credit—first, for providing the setting that stimulated such investigators and, secondly, for preserving so well the results of their labors.

A LEPIDOPTERIST REVIEWS THE SOCIETY'S SUPPORT IN LEPIDOPTERA RESEARCH

BY WILLIAM T. M. FORBES
Cambridge, Massachusetts

Of the early American scholars who dealt with the Lepidoptera before the founding of the American Entomological Society, the "Father of American Entomology," Thomas Say was one, several of whose notes appeared in the first series of the *Journal* of the Academy of Natural Sciences of Philadelphia. Say, a native Philadelphian, was one of the seven founders of the Academy.

Another of the pioneer group of Pennsylvania students was Dr. Brackenridge Clemens, the first critical student of North American Microlepidoptera, whose contributions appeared in the *Proceedings* of the Academy in the fifties of the last century, and later in the early *Proceedings* of the Philadelphia Entomological Society, the early corporate name of the American Entomological Society. Service in the Medical Corps of the United States Army during the Civil War forced the discontinuance of his studies and later, after his death in 1867, Clemens' most important collection, rich in type material, passed by bequest to the Academy of Natural Sciences of Philadelphia. Later the English lepidopterist Stainton reprinted the greater part of Clemens' contributions as an intrinsic part of our knowledge of the Microlepidoptera. In addition Clemens published in the Academy *Journal* and its *Proceedings* revisionary papers on the Sphinges and Bombyces.

Another early Philadelphia student of the Lepidoptera, who collected much but published little on the subject, was Titian Peale, one of the artist sons of the gifted Charles Willson Peale. Titian Peale was a friend of Thomas Say, and as an Academy representative was a member of the United States Exploring Expedition under Wilkes. His collection, much of it taken over a hundred years ago and including Say's original (hence type) specimen of *Chionobas semidea,* is one of the treasures of the Academy's Department of Insects. Many years after the passing of Titian Peale in 1885 I had occasion to borrow some milkweed butterflies from South America, and among them was a specimen

from the collection of Titian Peale. Even the versatile Joseph Leidy, who was also a member of the American Entomological Society, once touched the field of the Lepidoptera in a paper "On the Tobacco Worm," published by the Academy in 1882.

In its early years the American Entomological Society, under its original corporate name of the Philadelphia Entomological Society, published a considerable number of papers on Lepidoptera by Augustus R. Grote, whose home was in Buffalo, New York. He also published Lepidoptera papers in the Society's publications jointly with Coleman T. Robinson. Grote's numerous contributions saw the light in issues of the Society over the years from 1862 to 1882. The main Robinson collection eventually passed to the American Museum of Natural History, while Grote's personal collection largely went to the British Museum. The collections of the American Entomological Society, however, possess well over one hundred of the types of these authors. Grote also reported in the *Proceedings* of the Society for 1865 on certain groups of Lepidoptera from Cuba owned by the Society, largely from the Poey Collection, which had been purchased and presented by Dr. Thomas B. Wilson, and in this study he described the wonderful little moth *Ecpantheria albicornis*.

The Society also published an extensive series of Lepidoptera papers by William H. Edwards, these seeing the light in the *Proceedings* and its successor, the *Transactions*, in volumes extending from the first one of the former to the issue of 1884 (Transactions volume XI).

Following these earlier names in the Society's publications we find among others John B. Smith, whose work on the Noctuidae is known to all those familiar with that family, and with whom Grote argued on everything concerning the Noctuidae. Grote continued his dissents even long after he had moved to Hildesheim, Germany. Smith published many papers in the Society's publications, including his monograph of the Sphingidae in volume 15 of the *Transactions*.

Of a synopsis of the Lepidoptera of North America planned by the Smithsonian Institution, and of which but two others were published, the Society brought out in its tenth volume of the *Transactions* C. H. Fernald's "Catalogue of the Tortricidae."

Another lepidopterist to whom the Society opened its pages in the closing years of the nineteenth century was G. D. Hulst, who in 140 pages of volume 23 of the *Transactions* applied Meyrick's then new classification to our fauna. Other famous names among lepidopterists who were non-residents of the Philadelphia area, and whose early work was, at least in part, given to the world by the American Entomological Society, appear in the eighties and nineties—Holland with several papers on the African fauna; Dyar, who started one of his series in volume 13 of the *Transactions*, but continued it in the Journal of the New York Entomological Society when that journal started, and later added in volume 21 of the American Entomological Society's *Transactions* (1894) a revision of the Notodontidae, the latter with Neumoegen's collaboration.

When I first visited the Academy I met in the Society's quarters Dr. Henry Skinner, then the Curator of Insects and Secretary of the American Entomological Society. As lepidopterists we had our discussions, and sometimes arguments, but I no longer remember which turned out right on any particular issue. Most often these were about butterflies—what were species and which were their correct names, the Rhopalocera being Dr. Skinner's greatest field of interest. Later, however, when I came to write the "Lepidoptera of New York" in what became its final form, we both agreed that it should start with the primitive rather than the more advanced forms, and "micros" became the first to study. This meant to me the Philadelphia collections, as the Clemens series was basic with so many of our "micros." It was Dr. Skinner who guided me and helped me recognize which specimens might be considered types, for Clemens, like most entomologists of his time, thought of his whole series as representing the species—those obtained after as well as before the species was named and described.

And to bring this account more into line I must note the work over the years which the Academy and the Society have produced from the pen of Dr. Annette Braun, one of our present great "micro" scholars. Many authentic specimens, as well as some types, of her studies will be found in the Philadelphia series, along with the classic Clemens and Chambers series. In 1921 she

described in the Academy's *Proceedings* (volume 73), from the northern Rockies, one of the oddest of these little moths found on this continent, which she called *Acanthopteroctites*, one of those unusual things which we hesitate in giving even a family association. It is in any case the second most primitive genus of the kind known from North America.

So I conclude this brief sketch with the wish that the Society and the Academy may continue with their high standard, as well as the hope (as a lepidopterist) for more volume in their work on the Lepidoptera without curtailing any activity in the other fields of entomological research.

THE INSECT COLLECTIONS OF THE AMERICAN ENTOMOLOGICAL SOCIETY

BY JAMES A. G. REHN

Curator of Insects, Academy of Natural Sciences of Philadelphia

At the meeting of the Society held on November 28, 1859 the formation of a general collection of insects was approved, and a committee appointed to obtain suitable cabinets for the specimens. Funds for the cabinets, we are told, were promptly contributed and these were made by one of the founder members of the Society, James Ridings. A number of these cabinets, now one hundred years old yet reasonably tight and usable, are still to be seen in the Insect Department of the Academy of Natural Sciences. The original plan, which was followed for a number of years, placed the responsibility for the development of the series of individual orders of insects in the hands of small committees of the members, who were then also responsible for the specimens placed in their charge.

The first series of specimens given to the Society in response to the resolution proposing the creation of a collection came from Dr. Thomas B. Wilson, who then presented representatives of one hundred species of North American Coleoptera. In 1860 Mr. Ezra T. Cresson presented his entire collection of Coleoptera, and in 1861 many additions were received, the chief donors being Dr. Wilson, Dr. George H. Horn, John Pearsall, J. B. H. Bland, William Evett, Henry Ulke, and J. D. Wingate. During 1861 it was reported 520 species and 8885 specimens of Coleoptera were added, then making the total for the order in the Society's series 2550 species and 20,210 specimens, including a few types of species described by Dr. Horn. The Lepidoptera series were then said to represent 519 species and to consist of 3414 specimens, or an increase for the year 1861 of 198 species and 2169 specimens of that order. The Diptera series then comprised 224 species and 561 specimens, an increase for the year of 75 species and 235

specimens, including certain types from Baron Osten Sacken. The Hymenoptera series then totalled 136 species, and the other orders were represented by 249 species. From January, 1860, to December, 1861, representatives of 3678 species of insects were placed in the collection.

In 1862 Dr. Wilson added 496 species of various insects, including the types of a number of the same described by Ulke, Norton, and Horn, while a number of Bland's types of Coleoptera and one of Lepidoptera by Grote were also added that year. The same year Baron Osten Sacken presented a collection of cynipidous oak-galls and flies. During 1862 there were added 1514 specimens of all orders. At the close of that year the collection was reported as containing 2979 species of Coleoptera, 1404 species of Lepidoptera, 217 of Hymenoptera, 271 of Diptera, and 321 species of Neuroptera, Orthoptera, and Hemiptera, or a total of 5192 species. In 1863 Mr. William H. Edwards presented a large and beautiful collection of European moths, and the same year Dr. T. B. Wilson presented the original insect collection of Dr. Felipe Poey, of Havana, Cuba which contained Coleoptera, Hymenoptera, and Hemiptera. The same year important additions were also given by S. S. Rathvon, Augustus R. Grote, Benjamin D. Walsh, William Saunders, of London, Ontario, J. H. B. Bland, and Henry Ulke, these including a number of types of species by Grote, Bland, and Ulke.

In March, 1864, Horner F. Bassett, of Waterbury, Connecticut, presented a series of cynipid galls and gall insects, and at the end of that year it was reported that the total number of determined species of insects in the collection was 12,025, an increase of 2000 species for the year 1864.

In June, 1865, Rathmel Wilson, the Executor of the estate of his deceased brother, Dr. Thomas B. Wilson, a founder and patron of the Society, presented the collection of insects accumulated by the latter, totalling 18,873 specimens of various orders, of which 12,012 were Coleoptera and 5347 Diptera. The cabinet which originally contained this collection is now one of the historic possessions of the Society. In March, 1867, Mrs. S. B. Clemens, the widow of Dr. Brackenridge Clemens, presented the very important collection of Microlepidoptera which he had as-

sembled and which formed the basis of his classic studies of that group. Originally this collection was contained in glass-sided boxes, bound with leather covers as books, with the specimens pinned on small cork gummed to the glass, each cork with a printed number which corresponded with a numbered listing of names and localities placed on the inside of the "book cover." This method was also used by Titian Peale, one of the sons of Charles Willson Peale, whose historic insect collection, so preserved, is today one of the treasured possessions of the Department of Insects of the Academy of Natural Sciences of Philadelphia. Later the Clemens specimens were transferred to Ridings-type book boxes, and in the twenties of the present century to the standard type of glass-top box now used for virtually all the insect collections housed at the Academy of Natural Sciences. The Clemens collection is the most important single historic collection of North American Microlepidoptera in existence, and its inspiration has been responsible for the more recently assembled collateral collections of the same group of insects now to be found in the Philadelphia series.

Dr. William H. Ashmead, the great scholar of the Hymenoptera whose ancestral stock had been Philadelphian, presented to the Society in its earlier years many specimens, including certain types of species of Cynipidae, and in 1885 he placed in its hands a collection of parasitic Hymenoptera. In 1886 Mr. Henry Wilt presented the large collection of Coleoptera assembled by his father, Charles Wilt, as a memorial to one who was a founder of the Society. At the same time the Lepidoptera collection made by Charles Wilt was purchased by the Society.

In 1897 the Society lost one of the most distinguished of its early members in the passing of Dr. George H. Horn, who bequested to it his very extensive and important collection of North American Coleoptera. This contained over 67,000 specimens and approximately 1500 types. In 1899 an important collection of exotic Coleoptera assembled by Dr. H. G. Griffith was acquired, which added greatly to the important series of extralimital Coleoptera in the Philadelphia collections.

In 1901 Homer F. Bassett, of Waterbury, Connecticut, long an outstanding figure in the study of the Cynipidae, presented his

important and basic collection of North American galls and gall-flies which included the greater part of the material on which his studies had been based. As he desired when presenting it, this has been maintained as a separate collection. The same year Mr. E. T. Cresson presented his collection of Hymenoptera with the understanding that unique specimens, whether types or otherwise, would not be loaned. This collection was then the largest collection of Hymenoptera privately owned in America and contained considerably in excess of two thousand types.

In 1902 Mr. S. N. Dunning, of Hartford, Connecticut, presented his collection of Hymenoptera, consisting of 5440 specimens, and also a collection of Coleoptera. The following year the heirs of Charles A. Blake, who became a member of the Society in 1860, gave to the Society his extensive collection of Lepidoptera. Many smaller lots of material, too numerous to mention specifically, were added between 1870 and the early years of the twentieth century.

Problems of space and housing were naturally pressing increasingly upon the Society as its collections increased in bulk; also in the latter part of the nineteenth century and the earlier years of the twentieth the entomological collections owned by the Academy of Natural Sciences of Philadelphia greatly increased in extent and importance. Curatorial supervision had become a matter of increasing concern. As an extension of earlier working agreements between the two organizations, an arrangement was made and approved by the two bodies in 1915 by which the Society deposited its collections in perpetuity with the Academy, the latter body, on its part, assuming responsibility for space, housing, and curatorial supervision. Following this agreement the studied series so deposited have ben uniformly housed entirely in either standard Schmitt boxes or in a larger glass-top type developed by the Academy about the time the arrangement was completed. These boxes are now largely housed in modern steel cabinets, the remainder in a Brock type of tinned iron case which was first designed by the Academy for this purpose about the turn of the century. Each year a portion of these Brock cases is retired by replacing them with steel double-door cases, which transfer is exceedingly simple as all

studied material in the Brock cases is contained in either Schmitt boxes or the larger Academy standard. Type material is housed in the small Schmitt boxes so that any possibility of accident will involve a minimal number of specimens. The steel cases now used are readily adaptable internally, if desired, to hold racks for the smaller units of type boxes. The segregation of types has been an institutional policy in regard to insects for some decades past.

The history of the entomological collections directly owned by the Academy of Natural Sciences of Philadelphia, which have been developed by gifts, purchase, exchange or as a result of its own field investigations, is not covered in the present resumé. These collections are very extensive, in one case at least as comprehensive and cosmopolitan as any other in existence. When considered with those which have been brought together by the Society and its members and patrons, very many of whom have been or are members of the Academy as well, the combined representation constitutes one of the four largest assemblages of insects in America, and one of its three greatest type repositories.

THE LIBRARY OF THE AMERICAN ENTOMOLOGICAL SOCIETY

BY HAROLD J. GRANT, JR.
Chairman, Library Committee

From the first, the library of the American Entomological Society has been one of its most important and useful possessions. The early growth of the library during the Society's first fifty years has already been recorded by E. T. Cresson, Jr. in the 1909 history published by the Society. These brief remarks are intended to cover the period 1909–1959.

In the last fifty years the library has continued to keep pace with the voluminous literature of entomology. No single large donation of volumes has been received during this time, but significant additions have been made from restricted endowment funds to permit the acquisition of necessary and desirable items. Until 1947 the Society maintained and added to its library without outside assistance of any kind. Purchase of books, exchanges, binding, cataloging, and circulation were all done by the librarian with occasional volunteer help. By that year the size of the library, the complexities of its operation, and the ever increasing use being made of it by researchers both within and outside the Society called for an operational change. A committee was formed to explore the feasibility of depositing the library with that of the Academy of Natural Sciences of Philadelphia and late in 1947 an agreement was reached between the two institutions. Under the terms of this agreement, the Society deposited its library with that of the Academy while retaining title to it. The Academy agreed to maintain the library, catalog it, and to supervise its circulation among members of the Society and the Academy. In return, the Society agreed to purchase or exchange its periodicals for all entomological books, periodicals, and serials entering the combined libraries. In addition, the cost of binding this entomological literature was to be borne by the Society. This agreement has been of mutual benefit.

At the present time the Society's library consists of approximately 10,000 items exclusive of an equal number of reprints and

separata. Every major and most minor entomological periodical and serial is either purchased or exchanged for by the Society. Insofar as it is aware of them, every book dealing with the systematics, distribution, morphology, and physiology of insects is purchased by the Society. In addition, all important works of an economic nature are also purchased. The continuing objective of the Library Committee is the acquisition of all entomological literature germane to the pursuit of research in non-applied entomology. To this end the Society has achieved remarkable success.

THE HISTORY OF THE AMERICAN ENTOMOLOGICAL SOCIETY

BY HARRY W. ALLEN [1]

Moorestown, New Jersey

The history of the American Entomological Society is of particular interest at this time because it is in the one-hundredth year since its founding. We will review the first fifty years very briefly since that period has been described in considerable detail by Ezra T. Cresson and Henry C. McCook in a History of the American Entomological Society, 1859–1909, published in 1911. This paper then is primarily a history of the second half century of the Society, from 1909 to 1959. As we look back through the vista of these years, which have witnessed two great world wars and profound changes in the daily lives of nearly all the living inhabitants of this planet, it is truly remarkable how steadily the drive towards the goals of the founders of the Society has been maintained. They visualized the need for voluntary cooperative action in obtaining places to meet and to work; in the publication of their observations; in the creation of two highly important research tools, a good library, and large and well-arranged collections; and the advantages of a corporate status. These objectives, though they have long been realized, seem today as desirable as ever. Even though we have become habituated to looking to the Government for grants for nearly everything, the fact that so much in entomology has been accomplished by this Society in association with the Academy of Natural Sciences of Philadelphia, through private funds and voluntary workers, is still a matter of great pride.

In this paper we shall discuss, in turn, the principal events, the membership, the meetings, and the publications of the Society.

[1] The author is greatly indebted to J. A. G. Rehn without whose active interest and remarkable memory this compilation would scarcely have been possible. Through his long service for the Academy of Natural Sciences and this Society, he is able to recall in detail the rather complex relationships which have existed between these two organizations. The author is also much indebted to Harold J. Grant, Jr. for preparing the section on publications, and to Philip P. Calvert for notes on the long period during which he has been active as a Society member.

Since the history of any organization is a composite of the ideals, experience, and activities of its members, and since some few individuals have contributed so greatly to it, we have presented biographical sketches of several outstanding members.

PRINCIPAL EVENTS

On February 11, 1911, the Rev. Henry C. McCook made some observations relative to the history of the American Entomological Society during its first fifty years, which are eminently appropriate on our one-hundreth anniversary. He stated that "it seems hardly creditable, in view of present conditions, that fifty-two years ago the New World had no society devoted wholly to the study of insects. Yet so it was, on February 14, A.D. 1859, when three students of insects met in the house of Mr. Ezra T. Cresson in Philadelphia and resolved to organize a society whose object would be the advancement of entomological science. In a few days (February 22) they brought together in the same place a small group of kindred spirits and fairly launched the Entomological Society of Philadelphia". From the earliest days its scope has been far more than local in character, so on the eighth anniversary the name was changed to The American Entomological Society. For many years it was the only entomological society of the United States whose interests were continental in scope.

Dr. McCook was impressed by a characteristic of the Society's founders which he called ". . . peculiarly Franklinesque", and explained that ". . . they were marked by simplicity, independence, earnestness, practical good sense, economy, and a foresight almost prophetic". They perceived the need for a satisfactory means of communication with colleagues working in widely separated areas, and with those living in the future, so they ". . . began almost immediately the publication of a journal of their proceedings. It did not even occur to them to appeal to city, state, or nation for help. They purchased fonts of type and a hand press, and set up and printed off, by their own labor, and out of business hours, . . . their discoveries, descriptions, and reflections thereon".

The three students who met at Mr. Cresson's house on February 14, 1859 to discuss the organization of an entomological so-

ciety, were Ezra T. Cresson, James Ridings, and George Newman. At the meeting they called on February 22, 1859, fifteen persons were present. Proposals of organization were made which were acted upon at a meeting held March 1, 1859, and at the next meeting on March 14, officers were elected. The twenty-one persons who participated in these events have been known since as the Organization Members. Their names appear in the history published in 1911.

In his paper presented in 1939 at the 80th anniversary of the founding of the Society, E. T. Cresson, Jr. devotes considerable space to James Riding whom he thinks was the nucleus of a group of young men of similar interests in natural history and who later organized the American Entomological Society. He states that James Ridings was " by trade a carpenter, cabinet maker, and loom repairer, . . . who practised a little medicine for the common ailments of his family and neighbors ". He was also a nature lover, and in an old diary for the year 1849, there are records made by him of moths and butterflies collected between 1849 and 1853, several years before the organization of the Society.

The first written communication read was that of James W. McAllister. The first verbal communication was by James Ridings, the vice-president. Apparently the first visitor was Baron von Osten Sacken, the famous dipterist, who was present at the meeting of March 14 at the house of Dr. John L. LeConte, the first president of the Society. The first Corresponding Member of the Society, elected March 28, 1859, was Baron von Osten Sacken of Heidleberg, Germany.

On November 28, 1859, the Society decided to start a general collection of insects, and much credit goes to James Ridings for his work in providing the first cabinets. By 1860, the Society had obtained rooms, and had started to build up a collection of insects and an entomological library. During 1861, a committee on publications was appointed, and with generous financial support from Dr. Thomas B. Wilson, publication was soon started. Among the first three articles accepted for publication was E. T. Cresson's " Catalogue of the Cicindelidae of North America ". Mr. Cresson has related that " in April 1862, the Society, through

the efforts of Dr. Wilson and Col. Craig Biddle, was incorporated by the Legislature of Pennsylvania ".

From August 1862 to 1876, the Society occupied a small two-story brick building at 13th and Rodman Streets, built for its use by James Ridings. During this period the publication of three serial series was launched. One was the well-known " Transactions of the American Entomological Society ", started in June 1867, and which succeeded the " Proceedings of The Entomological Society of Philadelphia," published from 1861–1865. The other, called " The Practical Entomologist ", was discontinued after being published about 3 years. The Society acquired its first substantial income-producing funds from two gifts by Dr. Wilson of $5,000 in bonds, and shares of Pennsylvania Railroad stock par value $5,000, received in 1864 and 1865. In 1867, Rathmel Wilson, brother of Dr. Wilson and executor of his estate, added $6,000 from the doctor's estate, in trust, for publication purposes. These two bequests formed the basis of the Thomas B. Wilson Publication Fund, which was, in gift, restricted to the " imprint of the regular quarterly publication ". The income from this bequest, supplemented in 1897 by another substantial bequest from the estate of George H. Horn, has helped to maintain the " Transactions " through the years, and now provides, jointly, about fifty-five percent of the necessary support.

On December 13, 1875, shortly after the completion of the new building of the Academy of Natural Sciences at 19th and Race Streets, the American Entomological Society moved to quarters there under an agreement arranged between it and the Academy. Under the terms of this agreement, twenty-five members of the Society became life members of the Academy. On May 12, 1876, an Entomological Section of the Academy was organized. From the time of the removal to the Academy until 1885, the " Transactions " was printed in a basement room on the southwest corner of Race and 19th Streets, in what is now the Department of Ichthyology, under the immediate supervision of the Publications Committee. Thereafter it was done by established printers.

On June 12, 1893, a Society committee was appointed to work out a better agreement with the Academy. Such an agreement was executed and signed on November 24, 1894 and was still in

force in 1909. Through it, new quarters were obtained on the floor above the Academy Library, then housed in the part of the north building adjacent to the Race Street entrance.

The record (see Ent. News 16:56–61, 1905) seems to show that the Entomological Society of America, the society which endeavors to have an interest in all aspects of the science, and which is the only North American entomological society which is essentially continental in character, had its genesis in Philadelphia in 1904. At that time several of the resident members of the American Entomological Society were active in the early stages of its organization.

On December 29, 1904, there was a joint meeting at the Academy of Natural Sciences of the Association of Economic Entomologists, the Entomological Section of the Academy, The American Entomological Society, and the Feldman Collecting Social, at which many distinguished entomologists were present. Dr. P. P. Calvert, who was then president of the American Entomological Society, was elected chairman of this joint meeting, and Dr. Henry Skinner, then recording secretary of the Society, was its secretary. At this meeting, Dr. Calvert discussed the desirability of organizing a national entomological society, and J. Chester Bradley, then a resident member of the American Entomological Society from Philadelphia, moved that a committee be appointed to consider the matter. J. Chester Bradley, H. T. Fernald and E. D. Sanderson were chosen for this committee.

The following evening, at a meeting of the Entomological Club of the American Association for the Advancement of Science which was held in the rooms of the American Entomological Society, a report was presented by this committee. They recommended the organization of a society which would be truly American in character, and in which all branches of entomology would be represented. A committee was appointed to take steps toward organization. The members of this committee were John B. Smith (of the American Entomological Society), C. P. Gillette, and J. G. Needham. A report by Dr. Bradley on the formation of the Entomological Society of America appeared in the November 1906 issue of Entomological News.

On February 15, 1909, eleven members of the Society, eleven associate members of the Entomological Section of the Academy,

and seven visitors gathered to commemorate the fiftieth anniversary of the founding of the American Entomological Society. By this time the Society seems to have passed through the strain and crises of its earlier years and to have settled on the tranquil pursuit of its main business, which was the publication of entomological information, the building up and care of a very valuable library of entomology, and the maintenance of an insect collection that, in association with those owned directly by the Academy of Natural Sciences, form one of the world's best.

The collection of the Society was deposited with the Academy in November 1915 when, in return, the Academy removed the requirement that Society members must also be members of the Academy. An agreement made in 1947 placed the library in the custody of the Academy for servicing and cataloging. However, actual title to both remains with the Society, and also the control of purchasing and binding for the library. Both the collection and the library are more fully discussed elsewhere in this publication.

For years previous to 1900, the Society paid a nominal salary to a curator who was expected to spend a designated portion of each week working on the collection. In that year the Academy appointed an "Assistant to the Board of Curators" who, from that time, has curated the Society's collection as part of his work. In 1925 the Academy established the present arrangement into departments, with full curators of same, and set up the positions of associate and of assistant curators.

At present, the only regular disbursements out of Society funds for personnel are a portion of the salary of a secretary, and small honoraria for an editor and treasurer.

A faunistic study of the Orthoptera of North America in which the Academy and the Society have been interested for many years is being pushed rapidly to completion through the allotment by the National Science Foundation of substantial funds to the Academy. The principal contribution of the Society will be in the publication of some of the monographic papers.

There have been fewer changes in this Society during the past fifty years than might have been expected. At its meetings, members still sit in chairs and at tables which Mr. Rehn thinks were

part of the original furnishings of the Society's building on Rodman Street, first occupied in 1862. The portraits of Thomas Say and John L. LeConte still look down on us, and the chairman of the meetings uses an ivory gavel presented by Louis Schneider nearly a hundred years ago. In or near the meeting room are several other memorabilia of the early days of the Society. They include a massive wooden insect cabinet built by Ridings, still containing glass-topped trays, neither in good condition. There are also numerous specimen boxes known as the Ridings boxes, which are still serviceable and still used for storing pinned specimens. Other reminders of the past which are maintained in the meeting room are the copper plate of page 43, volume 2, of the "Practical Entomologist" dating from 1867, and the old ballot box with white and black balls formerly used in the serious business of electing new members. Thus, while there can be no doubt that this Society treasures the past, its members usually do their work with quite modern equipment and are intensely interested in results obtained in the steady evolution of technology. It is our belief that this Society in its attempt to blend the old that is good with the new that is desirable is correctly attuned to the maturing culture of which it is a part.

The impetus given to The American Entomological Society during its first fifty years by the forceful and often well-to-do group of professional and business men who were then members continued on into the second half century. The publications that they started have become well-known throughout the world. The Society has in its possession some very valuable collections, and its library has been constantly and substantially enlarged. A portfolio of income-bearing securities has been gradually acquired and the income they produce largely defrays publication costs in excess of subscriptions. The Academy of Natural Sciences of Philadelphia has for many years cooperated substantially in the taxonomic and faunistic studies of insects by housing the library and insect collections, by employing curators, and by providing library service. It shares credit, therefore, with this Society in all that has been accomplished.

MEMBERSHIP

This Society was founded by individuals who were interested in entomology principally as an avocation. Much of their spare time and a considerable amount of their personal incomes were spent in advancing faunistic studies in a young country where thousands of undescribed species existed. It can scarcely be denied that they desired exclusiveness. There was an elaborate ritual of membership elections in which one black ball served to exclude a candidate. Until 1915 no candidate was eligible to membership in this Society unless he was also a member of the Academy of Natural Sciences, which long had its own elaborate system of electing members.

However, the trend toward democracy was discernible fifty years ago, and became more apparent during the period of great expansion in professional entomology. By 1930 there was a large group of professional entomologists stationed in nearby Moorestown, N. J., a smaller group as port inspectors for Philadelphia, and teaching or research in entomology was the major activity of several others at nearby universities, colleges, and experiment stations. Many of these became active members of the American Entomological Society, and attendance at its meetings during the 1930's was at least double what it had been during its previous history. Since World War II, Federal support of economic entomology has greatly decreased in the Philadelphia area, and so also has the teaching of entomology in local universities and colleges. However, there has been a great increase in professional pest control and in the entomological aspects of sanitation. At present the requirements for membership in the American Entomological Society are as broad and democratic as they could be. Anyone is eligible who has an interest in entomology.

MEETINGS

The meetings are no longer dominated by non-professional taxonomists, as they had been up to the first part of the second half century. Most of those who now attend are professionally engaged in entomology. They include teachers, research workers in

various fields including taxonomy, public health officials, government regulatory officers, consultants in industrial or military sanitation, and some other fields. Our Society still maintains a very active interest in taxonomy.

At the beginning of the second half century, the meetings were held at two-monthly intervals, alternating with meetings of the Entomological Section of the Academy until 1924 when the Section was abolished. They were devoted to necessary business and informal discussions, frequently participated in by nearly everyone present. Additions to the library and the collections were discussed, and written communications read. Occasionally distinguished visitors were present and they usually joined in the conversations. For years these were conveniently classified in the minutes under such topics as " Odonata ", " Orthoptera ", etc.

In the early 1920's Federal quarantine inspectors had become members, and thereafter interceptions of foreign insects were frequently mentioned. Since late 1924 meetings have been held at monthly intervals, except during the summer months. Before the end of this decade it became customary to have special speakers at some of the meetings. Many of these were resident members of the Society who discussed their progress in the taxonomic and faunistic studies of Orthoptera, Lepidoptera, Odonata, etc. In addition, economic work on the Japanese beetle so important locally, on mushroom insects, and even on the effects of the depression on economic entomology were special subjects on the program. However, even during the 1930's a considerable number of the meetings were limited to necessary business and the traditionally informal discussions, and during the 1940's the meetings reverted almost exclusively to them. The average attendance during the latter period sank to a low level since several of the most active resident members were in military service during the war period.

In 1954 there was an abrupt change. Through the able cooperation of several relatively new members, principally Museum staff, industrial entomologists, and college teachers, programs of speakers were arranged for all stated meetings. This method has been continued to date. In the main, these speakers have been visitors, and they have included many outstanding experts from

all over the United States. The discussions have covered a wide range of subjects of both general and economic entomology, such as the phylogeny of the orders of insects, the language of bees, luminescence among insects, insects and public health, biological control, and the chemistry of the modern insecticides.

The programs have always retained a part of the traditional procedure and some time at each meeting is reserved for informal remarks which may be initiated by anyone present. Most of our members seem to enjoy the relaxed atmosphere of these meetings, something which perhaps has gone forever from the much larger annual gatherings of the national scientific societies. For those who like atmosphere, it is pleasant to gather for dinner at one of the fine old restaurants on nearby Chestnut Street, and after the dinner to stroll through the empty and dimly lighted corridors of the Museum, take the self-service elevator to the fourth floor, and meet there with colleagues in the pungent air of old books and insect collections.

PUBLICATIONS AND RECORDS

The principle publications of The American Entomological Society are all well-known series to American entomologists. Of these, three are outstanding, containing many of the important original contributions to systematic entomology in North America. The " Transactions " of the Society is now in its eighty-fifth volume and continues as the publication medium for more lengthy papers on systematics and morphology. It is the regular quarterly publication of the Society. " Entomological News ", which has been published for sixty-nine years, contains shorter articles and notes of entomological interest. It appears in ten issues per year. The third of this series is the " Memoirs " of the Society, which contain works of a monographic nature. Sixteen of these have been published over the last forty-three years, with the interval between the publications of each " Memoir " gradually shortening. Within the next decade it is hoped that one " Memoir " will be produced every other year. These three series are the publications which, in large measure, reflect the industry and foresight of our predecessors and upon which much of the prestige

of the Society is based. However, they are by no means the only publications of this organization.

Since the first volume of the "Proceedings" of the Philadelphia Entomological Society was laboriously lifted, page after page, from a hand press in 1861, there has appeared a continuous stream of entomological literature bearing the Society's imprint. At first it was only the "Proceedings" which ran for six volumes. These were augmented in 1865 by "The Practical Entomologist", America's first journal of economic entomology, of which only two volumes appeared. In the following years numerous catalogues appeared, among them W. H. Edwards' on North American Lepidoptera, S. Henshaw's on American Coleoptera, E. T. Cresson's "Synopsis . . . of the Hymenoptera of America . . .", J. B. Smith, et al., on the Lepidoptera of Boreal America, N. Banks' catalogues of Neuroptera and later his Hemiptera-Heteroptera—all attesting to the Society being one of America's important clearing houses in the publication of entomological research. But there was more. Among the truly artistic works to appear (and now considered collector's items) were Edwards' colored plates appearing in his "The Butterflies of North America", and the "Illustrations of North American Lepidoptera-Sphingidae" by Weidemeyer, Calverly and Edwards of which it is said only fourteen copies were printed and distributed. The quality of the latter's colored plates must be seen to be appreciated.[2]

In all, the Society produced at least twenty-five separate publications in addition to the periodical literature. In the aggregate this Society has published 195 volumes, the bulk of which has been the result of original research.

It is perhaps of passing interest to point out that the greater part of this prodigious labor—and publication can be thought of only in terms of money and labor—was accomplished without benefit of a single salaried official, including the editors. All of the editorial work, with the exception of part of that done in the past thirteen years was accomplished in the "spare moments" of persons with full-time vocations.

The sources of information reviewed by the author include the following items.

[2] We are indebted to M. E. Phillips, former Editor of the Society, for first drawing our attention to this most interesting volume.

A history of the American Entomological Society, 1859–1909, by E. T. Cresson, with an introduction by H. C. McCook, was published in 1911. This 59-page pamphlet includes, as a supplement to the historical account, articles on the collections and the library, lists of officers and members during the previous fifty years, and a copy of the act of incorporation. Numerous copies are still available.

E. T. Cresson, Jr., on February 23, 1939 at the eightieth anniversary of the founding of the Society, read a paper on the history of the American Entomological Society which was not published. A typescript copy is deposited in the archives of the Society. Only a few pages are devoted to the period from 1909 to 1939. Fifty-eight of the sixty-six pages are concerned with the earlier history and include much material omitted from the history published in 1911. This article lists all officers of the Society to 1939.

The minutes of the Society meetings from February 14, 1859 to December 21, 1950 are in the archives, and those from 1951 to 1959 in a folio in the files of the Society. Those in the archives are bound in six volumes. Apparently the minutes of some meetings are missing, particularly from 1869 to 1872. Most of the first two volumes covering the period from 1859 to 1873 are in the beautiful script of E. T. Cresson. Volumes 4, 5, and much of 6 are typescript, but volume 6 includes some rough notes in longhand. With occasional omissions, the minutes of the meetings of the Society were published as items in the "News" for many years up to 1928.

The list of the officers and the members of the standing committees for the year have been published on the cover of the "Transactions" for many years. In addition to the lists of members published with the history in 1911 there are, in the archives, printed pamphlets of a complete list of members elected from 1859 to January 1, 1897 and another list of living members in 1930, with addresses. Other partial lists of members have been printed in the "News" from time to time. In the archives and library there are albums and a letter-filing drawer containing several hundred photographs of entomologists, including many Society members, past and present, and several group photographs of meetings and collecting trips.

In the archives there are also: two record manuscript books, one containing the proposals for corresponding membership, 1859 to 1938, and another for resident membership, 1859 to 1923; copies of the charter, the first by-laws and its several successive revisions; two record books of donations to the library, 1860 to 1896; 110 pages of membership accounts, 1859 to 1876; attendance charts (some typed, others in longhand) of meetings, 1859 to 1867; a rough floor plan of the two floors of the Society building on Rodman Street, showing the placement of tables and chairs, which are apparently the ones still in use by the Society.

A nearly complete list of the Society's publications from 1859 to 1948 was compiled by M. E. Phillips and appears in the "Proceedings" of the Academy of Natural Sciences of Philadelphia, C, pp. viii–ix, xxxiv–xxxvii.

BIOGRAPHICAL NOTES

The history of the American Entomological Society is intimately connected with the lives and works of the many individuals who have served it, so it seems appropriate at this time to discuss a few who have had the longest associations with the Society. In the history published in 1911 there are biographical notes on several whose service during the first fifty years was outstanding. In this paper we shall confine the discussion to individuals whose work for the Society continued into the second half century, or was confined to it. We regret that it is not feasible to mention the many others who have served the Society most faithfully for lesser periods of time. The material for six of these sketches has been obtained principally by abstracting biographical notes previously published at various times in the "Entomological News".

EZRA TOWNSEND CRESSON

Ezra Townsend Cresson (see P. P. Calvert in Ent. News 37:161–163, 1926) "with James Ridings and George Newman founded The Entomological Society of Philadelphia in February, 1859 (name changed to The American Entomological Society in 1867). Of this Society he served as Recording Secretary one

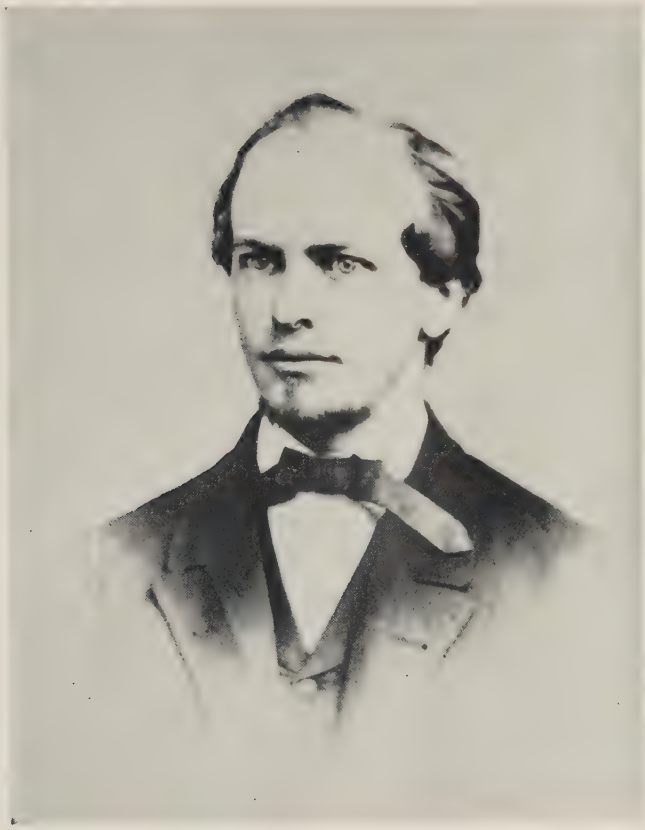
year (1859), as Corresponding Secretary sixteen years (1859–1874), as Curator eight years (1866–1874), as Editor of the *Transactions* forty-two years (1871–1912), as Treasurer fifty years (1874–1924)". To date, no one has equalled this record of long and devoted service to the Society.

" In 1861 he began a series of catalogues, synopses and monographs of the Hymenoptera of North America, numbering sixty-five papers by 1882, and summarized in a comprehensive *Synopsis of the Families and Genera of the Hymenoptera of America North of Mexico* (together with a Catalogue of the described species, and Bibliography), published in 1887." In 1916 he published, as a first number of the " Memoirs " of the American Entomological Society, a paper entitled *The Cresson Types of Hymenoptera* in which it is stated that 2,737 species are enumerated. Following it is a list of the author's entomological writings ". . . arranged in chronological order and numbered consecutively to enable the student to locate the paper in which the types are described ".

From August, 1865 to October, 1866 he edited " The Practical Entomologist " which was the first attempt in the United States at a journal devoted to economic entomology. " He headed the Publication Committee of the American Entomological Society which on November 28, 1889 recommended the establishment of ' The Entomological News ' ".

On February 15, 1909, when the Society celebrated its fiftieth anniversary, a resolution of appreciation was adopted which contained these words:

" It especially rejoices in the presence tonight of one of the three founders of the Society. Mr. E. T. Cresson, who from the very first has continuously exerted himself in its interests . . . and with his own hands set type for its publications, besides composing long series of entomological memoirs, principally upon the Hymenoptera, which have given to him and to the Society an honorable distinction, both at home and abroad. To many a younger student he has kindly given his aid, his advice and his example. He has encouraged and furthered the progress of entomology in the United States far beyond the limits of his home by his activity as author and by his gift of his most important,



EZRA T. CRESSON

valuable and extensive collection of Hymenoptera to this Society."

Mr. Cresson never served professionally as a scientist, teacher, or curator, and his study of insects was pursued as an avocation, while fully employed in a business career. This makes his long and arduous service to the Society and his great contribution to the taxonomy of Hymenoptera more truly remarkable. He quite evidently had the respect and affection of his associates who have

described him as amiable, gentle, exceptionally unassuming, and always willing to help younger students. It has also been observed that he had great zeal for method and order.

"Ezra Townsend Cresson, son of Warder and Elizabeth (Townsend) Cresson, was born June 18, 1838, at Byberry, Bucks County, Pennsylvania (and died at Swarthmore, Pennsylvania, April 19, 1926, in his eighty-eighth year). Ever reticent of his personal history he left few memoranda of his early life, even to his family. The active interest of Dr. Thomas B. Wilson in the Entomological Society of Philadelphia led to some financial connection of Ezra Cresson with that philanthropist, terminated by the latter's death in March, 1865. Cresson entered the employ of the Franklin Fire Insurance Company of Philadelphia in 1869. In October, 1878, he was elected its Secretary, a position which he held until his resignation on February 16, 1910, for reasons of health. In 1859, he married Mary Ann Ridings, daughter of his co-founder of the Entomological Society, and had four sons and one daughter", two of whom also had an active interest in entomology.

HENRY SKINNER

Dr. Henry Skinner (see P. P. Calvert in Ent. News 37:225–233, 1926) became a member of The American Entomological Society on March 9, 1883. He served as Recording Secretary eighteen years (1898–1915), and as President ten years (1916–1925). He was made an Honorary Member in 1926. He was Curator of the Society from 1885 to 1887, and from 1890 to 1915, in which year the Society's collections were placed on deposit with the Academy of Natural Sciences. He was Editor of the "Entomological News" from March 1890 to December 15, 1910.

He was elected a member of the Academy of Natural Sciences of Philadelphia in 1881 and was closely associated with the Entomological Section of the Academy until the Section was abolished in 1924. He was also in charge of the Department of Insects of the Academy from 1890 until his death. He served on the Academy's Committee of Publications for many years (Chairman for some years) and was Vice President of the Academy in 1918. For many years he gave public lectures on entomological topics in the Ludwick Institute course at the Academy.

HENRY SKINNER

His chief service to entomology is considered to be his editorship of the " Entomological News ". He strove, through a long series of editorials, to improve the size and quality of this journal and to make it valuable to a larger number of subscribers. " His humor and . . . incisiveness, even caustic at times, gave it a characteristic tone ". In March 1898 he noted that " instead of having a subscription list of 550, it should be twice that many and we could then make the ' News ' a journal of which to be proud ".

In November 1909 he was able to show that the " News ", which in 1890 had published 168 pages and no plates for the subscription price of one dollar, had steadily increased in size so that in 1908 it published 500 pages and twenty-five plates, still for the price of one dollar. The 1908 " News " reached its climax in the point of size. Dr. Skinner gave far more time and energy to the " News " than its editorial work, since for many years after December 1896 he also supervised its finances and distribution. He relinquished editorship in 1910 and was immediately elected Editor Emeritus.

His ideal for an entomological journal, and one he attempted to obtain in the " News ", was " one that covers the whole field and each number should contain matter that will please all its readers ". In illustration he advocated the use of half-tone at an early date, and three-color when it became a possibility. Many of his editorials were for the purpose of urging better entomological technique in the collecting and preparation of specimens. In this connection he once remarked, " We may also say, in passing, that we have coined a new word, ' Sloppydoptera ', which has reference to specimens captured with a baseball bat or temporarily loaned to the new baby as a plaything before being ' sent out ' ".

Between 1890 and 1921 he collected insects in many places in the United States, Canada, and Cuba. He built up a collection of butterflies, but his interest and principal contribution was in the study of the family Hesperidae, or skippers. He started work on this group about 1895, and it culminated in six papers by him and R. C. Williams, Jr. on " The Male Genitalia of the Hesperidae of North America ", 1922–1924.

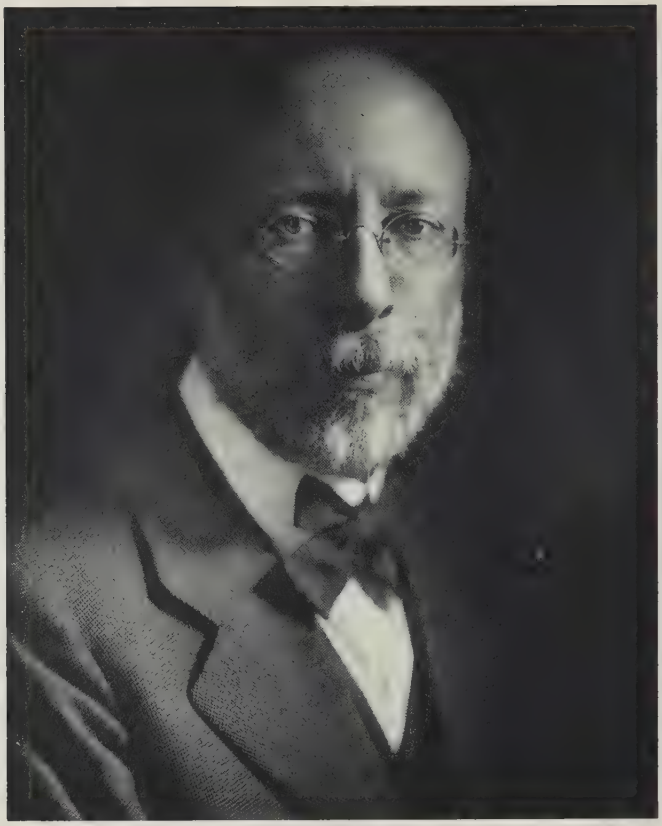
Dr. Skinner obtained wide recognition outside the field of entomology and his native Philadelphia. A partial list of the offices he held and the honors conferred follows. In 1906 he was the first Vice President chosen by the Entomological Society of America, and was its President in 1908. When international entomological congresses were suggested, he was Chairman of the Committee for the United States. In 1910 he attended the first Congress at Brussels where he was President of the Section on Nomenclature. Two years later he was at the Second Entomo-

logical Congress at Oxford where he was Vice President of the Section on Evolution, Bionomics, and Mimicry. In 1903 he was Vice President of the American Association of Economic Entomologists. From 1913 on he was a member of the International Commission of Zoological Nomenclature. In 1915 he served as Secretary of the Council of the American Association for the Advancement of Science, and in 1916 was its General Secretary. In 1911 the University of Pittsburgh conferred on him an honorary degree of Doctor of Science. He was elected a member of the American Philosophical Society in 1922.

Dr. Henry Skinner was born in Philadelphia on March 27, 1861, the son of William S. and Sarah (Irvin) Skinner. He attended the public schools and was graduated from Rugby Academy in 1879. From the University of Pennsylvania he received the degrees of B. S. in 1881 and M. D. in 1884. He was assistant to Dr. William Goodell in the practice of gynecology from 1884 to 1900. He retired from medicine in 1900. In 1886 he married Celia Angela Beck of Philadelphia and had one daughter and one son. About 1907 he moved to Ardmore, Pa., and still later to a farm between Narberth and Falls of Schuylkill where he lived until his death on May 29, 1926.

PHILIP POWELL CALVERT

Philip Powell Calvert (see Ent. News 55:1–2, 1944 and 62:3–40, 1951) was born in Philadelphia, Pa., on January 29, 1871. He married Amelia Catherine (Smith) Calvert, who also specialized in zoology at the University of Pennsylvania and Bryn Mawr College. His present residence is Cheney, Pa. where he has lived for many years. He obtained a certificate from the University of Pennsylvania in 1892, and the degree of Doctor of Philosophy was conferred on him in 1895. He spent the following year in post-doctoral study in Berlin and Jena, Germany. He has been associated with the faculty of the University of Pennsylvania since 1892, and as a professor of zoology from 1912 to 1939 when he retired as Professor Emeritus. Among the numerous societies of which he has been a member are the Society of Zoologists, the Ecological Society, the American Philo-



PHILIP P. CALVERT

sophical Society, the Society of Limnology and Oceanography, and the Society of Systematic Zoologists. He was elected Honorary Fellow of the Entomological Society of America and was its President in 1914.

Dr. Calvert became a member of the American Entomological Society in 1893. He was Corresponding Secretary of the Society for one year (1925), and President for seventeen years (1899–1915). He was Associate Editor of the "Entomological News"

(1898–1910), Editor (1911–1943), and Editor Emeritus since 1944. He has thus maintained a continuous editorial connection with this journal for sixty-two years. He joined the Academy of Natural Sciences of Philadelphia in 1892, and has been for some years a Research Associate, and member of its Publications Committee. As Editor of the " News " he has, over the years, written and published several hundred separate articles, including many short reviews on current literature and editorials on a wide variety of topics. He has also prepared biographical notes and obituary notices for scores of deceased entomologists.

He has long had a broad interest in zoology, particularly in the seasonal distribution of organisms in the tropics, and in the growth rates of animals. During sabbatical leave from the University of Pennsylvania he spent a year (1909–1910) in zoological research in Costa Rica. Much of this time was spent on the study of dragonflies, but it provided an opportunity to prepare, in joint authorship with Amelia Smith Calvert, a 577-page book on the natural history of Costa Rica, published by Macmillan in 1917.

In the faunistic field he has made a large and significant contribution to the study of the dragonflies. In a bibliography of the articles published by him (R. G. Schmieder and M. E. Phillips, Ent. News 52:3–40, 1951), about 190 of the 752 articles listed (1889 to 1950) concerned Odonata. In 1956 he brought this long study of the group to a fitting close with the publication of a monograph of 251 pages and many plates on the Neotropical species of the subgenus *Aeschna*.

Regarding the long series of editorials in the " News ", the new editors in 1944 stated " For thirty-three years he has been seasoning the ' News ' with his own particular flavor which in terms of the kitchen we might describe as well salted, with a judicious use of pepper. The pepper may have caused an eye to smart now and again, but we think the consensus of opinion is that the flavor has been agreeable ". For many years since his retirement, Dr. Calvert has had a desk at the Academy where frequently he would be found at work. Even in his eighty-eighth year he visited it several times, always walking the four blocks to and from the interurban station, and on these visits he usually

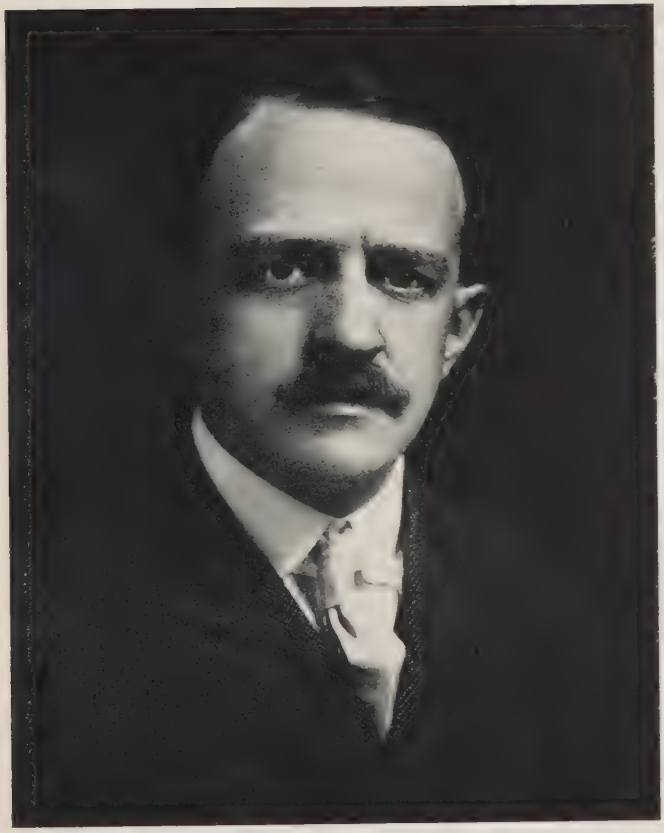
ignored elevator service and climbed the five flights of stairs to the top floor of the Academy. Some of his associates, younger by two or more decades, have long marveled at his persistent vitality.

EZRA TOWNSEND CRESSON, JR.

Ezra Townsend Cresson, Jr. (see P. P. Calvert in Ent. News 60:85–90, 1949), son of Ezra T., and brother of George B., was the third member of this family to do outstanding work in entomology. He became a life member of the American Entomological Society on December 28, 1905. He served as Vice President of the Society for one year (1947), Treasurer for three years (1926–1928), Corresponding Secretary for nineteen years (1909–1911, 1932–1947), and Librarian for forty-two years (1906–1947). He was elected an Honorary Member October 23, 1947. He became a life member of the Academy of Natural Sciences in 1905 and was Assistant to the Board of Curators for the Academy from 1908 to 1924, and Associate Curator of the Academy from 1925 to 1947.

Mr. Cresson, over many years, was very active and efficient in his curatorial work at the Academy. A most appropriate tribute to this work was received in a letter from Nathan Banks, who had himself retired as Curator of Insects at the Museum of Comparative Zoology at Cambridge, Massachusetts, which stated " The retirement of Ezra T. Cresson, Jr. moves me to express as forcibly as possible his great value, not only to the Philadelphia Academy, but to the numerous entomologists who depended upon him for information of types. He labored steadily in the most important, though often overlooked, work of preparation, arrangement, and preservation of the collection. Such men are the foundation stones of a museum ".

He was editor of the " Transactions " and the " Memoirs " of the Society from 1927 to 1945. He was elected Associate Editor of the " News " in 1910, and remained on its staff until his death. To many workers scattered over the world, he was perhaps best known for his bibliographic compilation of current entomological literature published each month in the " News ", in which he was coauthor with J. A. G. Rehn from January 1910 to December 1924, and author from January 1925 to December 1938.



EZRA T. CRESSON, JR.

From 1906 to 1945 his published papers totalled about 144 titles. He accomplished his major work as a specialist on the flies of the family Ephydridae on which he published fifty papers. From a memorandum found among his papers, he stated, regarding the ephydrids, "When the study began, in 1908, the Academy's collection contained five species, twelve specimens. At the present it contains about 600 species, 340 of which have been

described as new, (and) over 8,000 specimens. The North American series contains over 275 species. Over 26,000 specimens have been examined and determined during this study. This collection is the largest in the world and contains about 75 per cent of the known species ". He also published during this period scattered papers on the dipterous families Ortalidae, Trypetidae, Mydaidae, Sapromyzidae, Scenopinidae, Pipunculidae, Bombyliidae, Scathophagidae, Sciomyzidae, Micropezidae, Neriidae, Asilidae, Empididae, Psilidae, and Xanthophagidae. He wrote two papers on collecting and mounting micro-diptera, and six of wider scope on Diptera.

Dr. Calvert has stated he had planned a monograph of Ephydridae, ". . . as was obvious from his conversation and from hints in his published papers. In the last years of his life he realized that failing eye-sight and general health put this hope outside the range of possibility and he concentrated his energies on a series of 'systematic annotated arrangements of the genera and species' of the Ephydridae of North America, the Neotropical, Ethiopian and Indo-Australian faunas. At the time of his death he was engaged on such a manuscript and had typewritten 42 pages in evidently final form; this has been completed under the care of his associates at the Academy and has appeared in volume seventy-five of the 'Transactions' (1949) ".

In his study of the Ephydridae he has stated that he was greatly aided by Dr. Carl Zerny of the Naturhistorischen Museums in Vienna, and by Dr. Kertesz of the Musée National Hongrois. Through their liberality he was able to examine and obtain firsthand information on many species described by Weidermann, Meigen, Schiner, and Becker. Four papers in the " Transactions " (1925–1932) gave the results of his study of the Vienna collection. " In the course of this study, the types of new species, although derived from the Vienna Museum, are now in the Academy of Natural Sciences of Philadelphia ".

Dr. Calvert has observed that " he had much of the technician in his makeup and devoted much time and thought to methods of doing all sorts of things, accumulating many devises for rapid mechanical manipulation ". He gave considerable attention to collecting and mounting—a matter of especial importance in the

study of very small flies such as some of the Ephydrids. He also designed a very useful pinning forceps which has been sold for many years by a well-known firm furnishing entomological supplies.

" Ezra Townsend Cresson, Jr. was born in Philadelphia, December 18, 1876 and died at Swarthmore, Pennsylvania, April 8, 1948.

" His mother was Mary Ann Ridings, daughter of James Ridings, co-founder of the Entomological Society, an active collector of insects at Philadelphia, in Colorado, Kansas, Georgia and Virginia.

" In 1881 the Cresson family moved from Philadelphia to Ardmore, and in 1883 to Swarthmore, both in Pennsylvania. From his home in the latter, Ezra Junior attended successively Hilldale Cottage School (Miss Richard's) near Rutledge, Oakdale School, the Friends' School in Media, and the Drexel Institute of Technology in Philadelphia ". At various times, 1896 to 1898, he was enrolled at the Institute and pursued courses in mechanical drawing, mechanics, shopwork, and machine construction, but did not receive a certificate or diploma.

After leaving the Institute he was employed by the George V. Cresson Company of Philadelphia, and subsequently by the Morse Elevator Works of Philadelphia, and when this company was taken over by Otis Brothers and Company, Cresson went with them. However, his employment in industry must have terminated before 1908 since he was professionally connected with the Academy from that date until near the time of his death. He visited the western United States in the fall of 1907, at about the time he began to collect and study Diptera, and was registered as a special student in entomology at the University of California during the semester terminating May 1908.

" He was interested in music, played the piano, took lessons on the organ from the celebrated Henry Gordon Thunder, and for a time played the organ in the Episcopalian church at Swarthmore ".

The writer had frequent contacts with Mr. Cresson from 1926 to 1935. Although, like all active specialists, he must have begrudged time required by other activities, I found him always

genial to visitors, and extremely helpful in the examination or loan of Museum material, and in the preparation of manuscript.

JAMES A. G. REHN

James A. G. Rehn (see M. E. Phillips, Ent. News 61:85–88, 1950) was born in Philadelphia, Pennsylvania, October 26, 1881, and is now a resident of Sharon Hill, Delaware County, Pennsylvania. He was educated in the public schools of Philadelphia. He married Dorothy Holman of Stafford Forge, New Jersey, in 1906, and has one son, John W. H., who is also an entomologist and a specialist in Orthoptera, as well as a medical entomologist.

" In the American Entomological Society, Mr. Rehn's activities have been . . . constant and varied. For many years he has . . . played some vital role in the conduct of its affairs ". Although he did not become a member of the Society until 1910, he was an associate of the Entomological Section of the Academy from 1900, when Society and Section were " practically synonymous ". He was Corresponding Secretary for ten years (1911–1915, 1926–1931), Vice President for nine years (1916–1924), President for seven years (1942–1946, 1952–1953), and Treasurer for twenty-eight years (1931–1959). He was also Editor of the " Transactions " for twelve years (1915–1926).

" The very extensive collections of the Society and of the Academy are in his charge, and for a long period he has aided visiting entomologists who have come in large numbers to examine insect material. He has also done the many and varied chores which fall to the lot of the Curator of an important department.

" In this age of dashing about from one occupation to another, it is gratifying to find a man who decided early in life what he wished to do and who gained an abounding enthusiasm for it which he was able to maintain undiminished for fifty-nine years. Mr. Rehn came to work at the Academy when he was about nineteen years old. In the intervening years he has attained an enviable reputation as one of the world's outstanding orthopterists, and at the same time has served the institution for which he works in many important ways. He has labored successively at the Academy as Assistant Curator; Associate Curator of In-

JAMES A. G. REHN

sects; and since 1933 as Curator in that department. He has also served as Recording Secretary, Secretary, Secretary of the Council and of the Board of Trustees, and at the present time is Corresponding Secretary. In the latter position he has maintained contact with many of the world's best-known natural scientists ".

Aside from Mr. Rehn's services at the two Philadelphia institutions, he has been active in many other organizations. He is a " . . . past president of the Entomological Society of America; a charter member of the Society of Mammalogists and of the Society for the Study of Evolution; a member of the Society of Systematic Zoologists and of the Society of Sigma Xi; a fellow of the American Geographical Society and of the American Association for the Advancement of Science; and a fellow and past president of the Delaware Valley Ornithological Club. During the first World War he served with the Military Intelligence Division of the U. S. Army, Counterespionage control.

" His contributions to scientific literature have been very extensive. Mr. Rehn entered the field of natural science at a period when the old-fashioned naturalist was just about to become extinct; when taxonomists were just entering into the higher and more glorified status of specialists. However, there still remained a remnant of the idea that breadth of knowledge in a general field was a wholesome virtue. Thus we see reflected in his earlier activities, and to some extent in his writing, a greater diversity in subject matter than is often encountered today. His sixteen earlier publications in Mammalogy, and four as joint author, illustrate this point ".

The order Orthoptera has been his main interest for many years. At the close of 1958, he had published 263 papers in this field in addition to forty-one published jointly with Morgan Hebard and twelve with his present colleague, Harold J. Grant, Jr. Fifteen papers were published jointly with John W. H. Rehn. At the request of the Australian government, Mr. Rehn is preparing a monograph of Australian grasshoppers, of which three volumes have been printed and the fourth is in progress. Work is still in progress on the monograph of North American Orthoptera he planned many years ago with his former colleague, Morgan Hebard. The recent substantial grants of the National Science Foundation and association with Mr. Grant practically assure the final completion of this monograph. Five volumes have been planned, the first of which will be submitted for publication late in 1959.

The data already published by him places him " among the half dozen most productive scientific writers on the Academy staff in the nearly 140 years of its history. No other entomologist who has been a member of this Society has ever achieved this record ".

For a period of over fifty years Mr. Rehn alone, or with his coworkers, has covered most of the United States in a series of many collecting expeditions. His earlier collecting with Morgan Hebard is described elsewhere in this paper.

" Outside the United States similar expeditions have been numerous, including trips to Africa, Colombia, Costa Rica, Honduras and Brazil. Largely through his efforts, and those of

Morgan Hebard, a collection of Orthoptera has been built at the Academy which now exceeds half a million specimens—the finest in the world ".

During many recent years the collecting of Orthoptera in the Rocky Mountain and Western States has been continued by Mr. and Mrs. Rehn. They have crossed and recrossed the country many times during mid-summer weather, and spent several intervening weeks in arduous collecting.

On May 25, 1950, the Society devoted its meeting session to commemoration of Mr. Rehn's fifty years of outstanding service to entomology. Many friends were present, a gift was presented, and also an engrossed copy of a resolution " of appreciation and gratitude " from the Board of Trustees of the Academy.

At seventy-seven, Mr. Rehn walks briskly to and from the interurban station and spends the full day at his laboratory, five days a week, and is practically always present at the Society meetings. He has an encyclopedic memory of almost countless people and experiences of his long and varied career. He enjoys reminiscing with his many friends and frequently astonishes them with his keen memory of things long passed.

MORGAN HEBARD

Morgan Hebard (see J. A. G. Rehn, Ent. News 59:57–69, 1948) had a life-long interest in insects developed principally through his relationships with the Academy of Natural Sciences of Philadelphia. He was elected a life member while still a minor, and at his death was listed as a Benefactor, in recognition of his highly valuable gift of the Hebard Collection in 1945. At the Academy he was Curator of Insects for several years but accepted no salary. He also held the title of Research Associate and later, Research Fellow. Mr. Hebard regarded the attendance at formal meetings as a waste of valuable time, so except for the meetings of the Scientific Council of the Academy of which he was a member for over twenty years, he rarely attended any society meeting or conference. He was a member of the American Entomological Society for many years. He served as its Treasurer for one year (1925), and as Corresponding Secretary for eight years (1916–1920, 1922–1924). He was also elected a

fellow of the Entomological Society of America, and an honorary member of the Entomological Society of France, and of the Columbian Natural Science Society.

The manner in which Morgan Hebard, as a youth of sixteen, came to the Academy in 1903 to secure the identification of a few butterflies, met and became associated with Mr. J. A. G. Rehn in a life-time study of Orthoptera (1904–1946) is skillfully described by the latter. While their interest in Orthoptera became world-wide, their main interest over the years was the completion of a comprehensive faunistic study of the Orthoptera of North America.

An important part of their program consisted in systematic collecting in undisturbed areas of thinly populated sections, which over a long series of years, took them to the summits of many high mountains in the West, the Rocky Mountain States and the Southwest, to Death Valley and the Yuma, Colorado, Mohave, and Amargosa deserts in mid-summer, and many other places where specimens could be obtained only at the cost of rugged and arduous living. At first they collected on hiking trips from widely separated whistle stops, but later more luxuriously from automobiles equipped for camping. The costs of these expeditions over many years (1905–1928) were paid by Mr. Hebard. Over a hundred thousand specimens were obtained and written up daily in the field—many hundreds of pages of desirable field observations.

At some time during this period Mr. Hebard became personally interested in building up an outstanding collection of Dermaptera and Orthoptera. To the North American material he added, by purchase and exchange, large numbers of specimens from all over the world. Two well-known collections (Lawrence Bruner and J. L. Hancock) were purchased *in toto*. Where types were deposited elsewhere, many paratypes were secured by exchange. The Hebard Collection, formally presented to the Academy in 1945, contained about a quarter million specimens in which there were 1,369 type specimens and about 2,000 additional paratypes. It was then one of the best existing collections of these orders.

Mr. Hebard did not begin full-time study of insects until 1911. Thereafter he published individually, or jointly with Mr. Rehn,

MORGAN HEBARD

197 titles on Dermaptera and Orthoptera, mainly on the North American fauna, but also including papers on the fauna of South America, Asia, Australia, as well as some of the isolated Pacific Ocean island groups. While he contributed in a large and significant way to the faunistic study of one of the important orders of Insecta, years of crippling illness and an early death robbed him of achieving the goal he sought. Fortunately his life-long associate, Mr. Rehn, has had many additional years in which to

drive persistently on toward the achievement they jointly planned and worked for.

Morgan Hebard was born in Cleveland, Ohio, February 23, 1887, the only child of Charles Samuel and Hannah (Morgan) Hebard. On the paternal side his forebears were pre-Revolutionary Connecticut stock. Charles Hebard, Morgan's grandfather, was a successful lumberman, first in the Pocono region of Pennsylvania, and subsequently in the upper peninsula of Michigan. During his lifetime and that of his two sons, Samuel and Daniel L., the Hebard family greatly expanded its business and ultimately became owner of almost the entire area of the Okefenokee Swamp, a tract of about 500 square miles in southeastern Georgia, originally containing an enormous stand of cypress. This tract was subsequently transferred by the Hebard family to the United States as a wild life reserve. The Hebard family regarded Philadelphia as their home, although they had a summer home at Pequaming, Michigan and a winter home at Thomasville, Georgia.

Morgan Hebard, whose primary education was largely acquired from governesses and tutors who moved from place to place with the family, entered the Asheville School at Acton, North Carolina in 1904, and graduated from Yale University in 1910. He married Margaret Champlin Perry Claxton of Philadelphia in 1913. They had three children, but only two, the younger son, Morgan, Jr. and the daughter, Mrs. Richard Lloyd, survive their father. He had a great love for the out-of-doors and devoted spare time to trap-shooting, hunting, fishing, golf, and tennis. During the First World War he served as first lieutenant, at first in the Signal Corps, and later in Military Intelligence.

In the 1930's he was attacked by arthritis and, as it grew progressively worse, he spent long periods under treatment in hospitals in Philadelphia, New York, and Boston. Although there were temporary improvements, during the last few years the crippling effects became so bad that he was unable to make the trip from his home to the Academy. On December 28, 1946, when he had improved enough to be planning to resume trips to his office, he died suddenly of a heart attack.

From J. A. G. Rehn, who was so closely associated with him for forty-three years, we have a very sincere tribute to his many fine qualities. He repeatedly mentions his zest for orderliness, his persistence in driving toward any objective he had set for himself, his ability to concentrate and to accomplish a phenomenal amount of work in a short time. "Although . . . accustomed to luxury, he was perfectly at home in the most rugged situations and with people in all walks of life". He was ". . . possessed of an infectious humor . . . (and) was happy to help others . . . (but could be) quick-tempered and outspoken when confronted with injustice or incompetence. . . . All who knew him well . . . (considered him) . . . a charming, kindly, and brilliant associate".

ROSWELL CARTER WILLIAMS, JR.

Roswell Carter Williams, Jr. (see E. L. Bell, Ent. News 57:167–171, 1946) became a member of the American Entomological Society in 1915. He was Corresponding Secretary of the Society one year (1921), Recording Secretary for seven years (1916–1918, 1920, 1922–1924), and President for ten years (1926–1935). At various times he served as a member of the Society's Finance Committee and its Publication Committee.

He was elected a member of the Academy of Natural Sciences "on November 26, 1901, became an Associate Sustaining Member on February 21, 1928, and a Sustaining Member on January 16, 1929. He served as a member of the Scientific Council of the Academy from December, 1920, until his death. He was Chairman of the Committee on Accounts of the Academy from December, 1922 to October, 1924, when through a reorganization of the operations of the Academy the Committee was discontinued. In 1922 he was elected by the Council of the Academy to the post of Research Associate in the Department of Entomology which he held to the time of his death".

For many years Mr. Williams was interested in butterflies. Through his personal industry and gifts he built up an excellent collection for the Academy. He is known to have paid as high as $100 for single specimens to add to this collection. His studies of the family Hesperiidae were his principal contributions to entomology. He started publishing on this group in 1914, and sub-

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sequently described many new species. He was particularly interested in the butterflies of tropical America but also did considerable work with the American fauna north of the tropics.

For several years up to the time of Dr. Henry Skinner's death, Mr. Williams collaborated with him in writing a comprehensive work on the diagnostic characters of the male genitalia of the North American Hesperiidae. The results of this work were published in several papers, 1922–1924. From 1926 to 1940 Mr. Wil-

liams as author or as co-author with A. W. Lindsey or Ernest A. Bell, published numerous papers on the Hesperiidae, principally in the " Transactions ".

In 1931 Williams and Bell published jointly a paper on " Hesperiidae of the Forbes Expedition to Dutch and British Guiana " from material gathered in 1927. Mr. Williams helped to organize this expedition. In 1944 Mr. Williams and Mr. Kenneth T. Hayward of Tucuman, Argentina compiled jointly the Hesperiidarum Rei Publicae Aequatoris Catalogus on Equadorian skippers. Mr. Williams spent a great deal of time over several years in compiling information for this catalogue.

" Two weeks before his death Mr. Williams completed assembling specimens of butterflies for a map showing their distribution in the United States, which has been published in the July issue of the ' Holiday ' magazine and this, his last contribution to the Science of Entomology, is a tribute to his many years of interest in it."

" Mr. Williams was born in Brooklyn, New York, on August 21, 1869 and died in Philadelphia, Pennsylvania, on March 7, 1946 in his seventy-seventh year. He attended the Adelphi Academy in Brooklyn, graduating with a B.S. degree, and then entered Cornell University from which he graduated in 1892 with an M.E. degree. He was associated with Charles P. Steinmetz in the development of the ' Three Phase Power Transmission ' experimental work. He removed to Philadelphia and about 1896 entered the electric engineering and contracting firm of J. F. Buchanan & Company as a partner, and remained a member of that firm until his retirement from business in 1918.

" In World War I, Mr. Williams volunteered for war service and received the appointment of Captain in the Ordnance Department. He was appointed by Congress on the Board of Adjustment to represent the Government at Nitro, West Virginia and served throughout the war."

He married Carrie (Hamsher) Williams and they had four sons, Roswell Carter, III, Hamilton, Arthur P., and Charles M. Mr. Williams was described by his associates as a " cheerful, courteous, unassuming man, . . . (known as) ' Roz ' to his host of friends, (by whom) his memory will be cherished as long as they live ".

RUDOLF GUSTAV SCHMIEDER

Rudolf Gustav Schmieder has been a resident member of the American Entomological Society since 1925 and was elected an Honorary Member in 1952. He was Recording Secretary of the Society, 1931–1935, and President, 1936–1938. His outstanding service to the Society has been his many long years of editorial work, accomplished without remuneration. He has worked for the "News" for over thirty years as associate editor from 1928 to 1945, and since as its editor. From 1942 to 1952 he did a large part of the work (all of it from 1949–1952) of compiling the well-known *Entomological Literature* of the "News". The thousands of titles, comprising over a hundred printed pages annually, required of him an average of two full days' work per week. He has also contributed about sixty-five book reviews and a number of critical articles, essay reviews, and miscellaneous notes.

In research, he accepted the challenge for work in what are generally regarded as difficult fields. He has contributed a number of significant studies, generally physiological in nature, overlapping into histology, cytology, and genetics, which have appeared in such periodicals as the "Journal of Morphology", the "Anatomical Record", the "Biological Bulletin" and "Genetics". These have been concerned with the sources of control in the Hymenoptera, of metamorphosis, polymorphism, and diapause, and with sex determination. One of these articles on *Reproductive Economy in the Chalcidoid Wasp Melittobia,* published with P. W. Whiting in "Genetics" (32: 29–37), presented results of an interesting and significant study of inbreeding and outcrossing these parasitic wasps.

Dr. Schmieder has long been a research associate of the Academy of Natural Sciences of Philadelphia. He is a member of the American Association for the Advancement of Science, the Entomological Society of America, the American Society of Zoologists, and Sigma Xi.

R. G. Schmieder was born at San Diego, California, on August 26, 1898. He is of German ancestry on both sides. On the paternal side there are six successive generations of clergymen or pro-

fessors, and his maternal grandfather came to this country as a steel master from the Essen region in Germany. His father, who came to America to serve the immigrant Germans as a pioneer Lutheran clergyman, worked in the whole region between Winnipeg and the Rocky Mountains where he founded several churches. Rudolf's early years were spent at San Diego and Lyons, New York. He lived in Philadelphia from 1906 to 1940 where he attended the public schools, graduated from Central High School, and attended the University of Pennsylvania. At the University he obtained three degrees; A.B. in 1920, A.M. in 1922, and Ph.D. in 1927. He became an instructor in the Department of Zoology at the University in 1923, and has been assistant professor since 1937. For many years he was closely associated with Dr. P. P. Calvert, first as a student and later as a fellow teacher. In 1933 Dr. Schmieder married Marion Scott Irwin, also a biologist, who obtained her master's degree under W. A. Riley at Minnesota, studied a year at Yale University, then came to Philadelphia as a member of the editorial staff of " Biological Abstracts ". They have no children.

They have resided at Elwyn, Pennsylvania since 1940, and here Rudolf spends some of his spare moments gardening on his acre of ground. For many years he has been a stalwart supporter of the activities of the Society and is always willing to work on its committees. He has seldom missed a meeting, and his occasional observations at such events are always interesting, to the point, and usually flavored with a pungency which is unique.

Explanation of Plate

Group photograph taken at Centennial meeting. 1, Bertil G. Anderson; 2, C. W. Fleming; 3, Ashley B. Gurney; 4, Mrs. A. Hurwitz; 5, Lewis Roache; 6, Neal A. Weber; 7, Fred Jacobson; 8, Edward J. F. Marx; 9, Selwyn S. Roback; 10, Fr. Placidus Reischman; 11, Mrs. J. Chester Bradley; 12, Reece Sailer; 13, Carl Muesebeck; 14, J. Chester Bradley; 15, Karl Krombein; 16, Rudolf Schmieder; 17, James A. G. Rehn; 18, Raymond Q. Bliss; 19, Harold J. Grant, Jr.; 20, Michael Efimenko; 21, Harry W. Allen; 22, Mrs. R. Q. Bliss; 23, Maurice Philips; 24, Mrs. C. P. Alexander; 25, Mrs. E. A. Richmond; 26, Edward A. Richmond; 27, Mrs. Arthur Wells; 28, Arthur Wells; 29, Ross Arnett; 30, Charles P. Alexander; 31, Curtis Sabrosky; 32, John Schmitt; 33, Philip P. Calvert.

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